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AN ASSESSMENT OF PESTICIDE RESEARCH PROJECTS

Funded by the Ministry of the Environment through the Ontario Pesticides Advisory Committee

1982 - 1983

Ontario

The Ontario
Pesticides
Advisory Committee

Hon. Andrew S. Brandt
Minister

Gérard J. M. Raymond
Deputy Minister

Date Due

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PESTICIDE RESEARCH PROJECTS
FUNDED BY
THE MINISTRY OF THE ENVIRONMENT
THROUGH
THE ONTARIO PESTICIDES ADVISORY COMMITTEE

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Executive Secretary to the Committee

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OBITUARY

Dr. George S. Cooper, Chairman of the Ontario Pesticides Advisory Committee, passed away on June 9, 1983. Dr. Cooper was widely recognized as an international authority on pesticide development and use. During his distinguished career as a teacher, researcher, industrial manager, and advisor to government agencies and other organizations he made a major contribution to development of crop protection programs across Canada. The high esteem in which he was held by colleagues in industry, government, and universities was reflected in the many awards and honours bestowed on him, as exemplified by his election as President of the Canadian Agricultural Chemicals Association, as President and a Fellow of The Entomological Society of Canada, and as a Fellow of the Canadian Pest Management Society. As a member of the Pesticides Advisory Committee since 1971, Vice-Chairman from 1974-80, and Chairman from 1980-83, Dr. Cooper probably contributed more than any other single individual to the development of effective legislation governing the use of pesticides in the Province of Ontario.
Dr. Cooper was a strong supporter of the research program sponsored by the Pesticides Advisory Committee, taking a keen interest in all aspects of the work. Dr. Cooper was a colleague, advisor, and friend to many and his presence will be sorely missed.

Ontario Pesticides
Advisory Committee

RESEARCH PROJECTS FUNDED THROUGH

THE ONTARIO PESTICIDES ADVISORY COMMITTEE

1982 - 1983

I. SUMMARY

1) In 1982-83, the Ontario Pesticides Advisory Committee continued a program, begun in 1973, of funding research on pesticides. The objectives of the program are:

   (a) To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

   (b) To determine potential environmental hazards with pesticides currently in use.

   (c) To reduce pesticide input into the environment.

2) Forty-six research proposals totalling $719,182 were received.

3) Twenty-eight proposals were funded with a total value of $296,625. Awards averaged $10,594 and ranged from $3,500 to $17,500.

4) Four grants totalling $46,500 were awarded for studies on development of alternative pesticides.

5) Seven grants totalling $77,400 were allocated to studies on the behaviour and fate of pesticides in the environment and on potential environmental hazards to non-target organisms.

6) Seventeen grants totalling $172,725 were allocated for studies aimed at reducing pesticide input into the environment, while still achieving effective pest control.

7) The Pesticides Advisory Committee is very satisfied with the research progress made in 1982-83. It recognizes that with the limited funds available the program can be expected to act only as a catalyst in stimulating support by other agencies for research in the broad areas indicated in the Committee's guidelines, for which there is still an urgent requirement.

II. RECOMMENDATIONS

The Pesticides Advisory Committee recommends that:

1) The Ministry of the Environment continue to support research programs directed toward development of pest control programs which will not pose any serious environmental hazard.

2) The Pesticides Advisory Committee continue to supervise the program following guidelines which have been developed.

III. REVIEW OF THE RESEARCH PROGRAM

The Ministry of the Environment first allocated funds to the Ontario Pesticides Advisory Committee to sponsor pesticide-related research in 1973. Results have been summarized in Annual Reports from 1974-1983, inclusive, which are available from OPAC on request. Results obtained have encouraged the committee to recommend that the research program be continued under its supervision and the committee is gratified that this recommendation has been accepted. The OPAC research budget in 1982-83 was $300,000.

Terms of Reference developed by OPAC to govern the awarding of research grants are based on three objectives, i.e., the need to find suitable replacements for pesticides deemed hazardous and restricted for use in Ontario; the need to determine if pesticides in use pose any serious environmental hazard; and the need to develop more effective approaches to pest control leading to a reduction of pesticide input into the environment. The "Application for Research Support" (APPENDIX I) invited proposals in seven general areas relating to these three objectives. Invitations for applications for research support were widely distributed in January, 1982 to personnel in Ontario universities, industry and government (copies of the mailing list are available on request), with the deadline for applications being February 26, 1982.

Forty-six research proposals totalling $719,182 were received. Most (38) were from universities/colleges (Brock, Carleton, Guelph, Lakehead, Queens, Sault College of Applied Technology, Toronto, Waterloo, and Western). The remaining applications were submitted by industry or other organizations. (A list of titles of research proposals submitted for consideration by OPAC is available on request.) Applications were considered first by the research sub-committee (J.R. Carrow, G.S. Cooper, P.D. Foley, R. Frank, F.L. McEwen, G.R. Stephenson, J. J. Onderdonk, and C.R. Harris (Chairman), and then by the Advisory Committee. Twenty-eight proposals were accepted, valued at $296,625. Awards averaged $10,954 (range $3,500 to $17,500). Most of the grants were awarded to individuals at universities. Disbursement of research funds by organization is summarized below:

Organization	Number of Research Grants Awarded	$ Total Research Funds
University of Guelph	15	156,515
University of Western Ont.	7	77,050
University of Toronto	1	15,010
Sault College of Applied Technology	1	11,550
Other	4	36,500
TOTAL	28	296,625

Direction and progress of the research program were monitored by the Advisory Committee in several ways. Initially, some applicants were asked to modify their proposals to better meet the research guidelines. Informal contacts between the research sub-committee and some grant recipients were established. In June 1982, as part of the annual OPAC field trip, visits to some of the researchers receiving support were included in the agenda, thus giving OPAC members an opportunity to become acquainted with cooperating scientists and research in progress. In January 1983, OPAC sponsored a two-day research seminar at which recipients of grants discussed their research results. This meeting was attended by Advisory Committee members and >80 people interested in pesticide-related research. Each recipient of a grant was asked to provide OPAC with a summary of results (APPENDIX III). Published research reports relating to research sponsored by the Committee are listed in APPENDIX IV. APPENDIX V summarizes a ten year statistical review of grant disbursements.

Progress made in 1982-83 relative to the objectives of the research program may be summarized as follows:

OBJECTIVE 1: To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

Environmental and, more recently, health concerns have resulted in restrictions on use of a number of important pesticides in Ontario. Alternative control programs were sometimes available. However, in other cases alternative approaches to control were not feasible; or they did not prove to be satisfactory; or the substitute chemicals used presented their own special hazard, e.g., the high mammalian toxicity of some organophosphorus insecticides. In these situations, OPAC has funded research aimed at developing satisfactory methods of pest control. Four grants were awarded under this objective in 1982-83 totalling $46,500. Another study, funded in 1981-82 was also completed during this period.

Biting flies are nuisance pests and disease transmitters. For a number of years, the Ministry of the Environment has provided substantial support for research on biting fly biology and control, and further support was given in 1982-83. Completed research showed that habitat preference of mosquito adults varied with species, with some preferring wooded areas; another open field; and some being evenly distributed in a woodlot, field, and interface between. The effectiveness of adult sampling devices also varied with species; the CDC light trap baited with dry ice was the best overall sampling device. Research also indicated that development of mosquito larvae could be correlated with phenological stages of some common plants. Based on these results a technique for predicting times to initiate larval surveys and control programs was designed for use by abatement personnel (23)*. In related research funded in 1981-82 and completed in 1983, further work was done to asses the feasibility of using a flatworm (Planarians) to suppress mosquito breeding in catch basins. In laboratory studies, flatworms continued to show promise as predators of mosquito larvae; results

*Numbers in brackets refer to Abstracts included in APPENDIX III.

indicated that they were most effective when mosquito larval densities were low. In field tests, planarians were still present in 1982 in catch basins first inoculated in 1980 (30).

Support was continued in 1982-83 for research on rodent control in orchards. In a project initiated to identify the most effective economical method of controlling mice with chemicals, a study was begun to evaluate the effectiveness of poison bait (anticoagulant rodenticides) feeder stations in controlling meadow mice as compared to the conventional broadcast application (zinc phosphide). First-year results suggest that the bait station technique will be at least as effective as the broadcast application (25).

Research also was begun to identify possible alternatives to replace allidochlor, used to control weeds in onions grown on organic soils. Although none of the materials or combinations of materials tested were as effective as allidochlor, results did suggest that an early post-emergence application of oxyfluorfen followed by a later application of ioxynil might have potential (15). Another study was initiated to evaluate the efficacy, persistence and mobility in soil of triclopyr, an experimental herbicide which may have potential as a brush control agent (22).

OBJECTIVE 2: To determine potential environmental hazards with pesticides presently in use.

This objective promoted seven grants totalling $77,400. Laboratory and field studies on the persistence and behaviour of aldicarb in soil and water were completed. Results indicated that: 1) aldicarb oxidized rapidly in soil to the insecticidal sulfoxide and sulfone, both of which also were short-lived in soil; 2) persistence of aldicarb residues in soil was dependent on soil type and moisture; 3) aldicarb residues were very water soluble and mobile in soil; 4) persistence of the residues in water was pH and temperature dependent; 5) aldicarb residues were absorbed rapidly by the potato seed piece which served as a reservoir, supplying toxicant to the foliage over several weeks; 6) no significant aldicarb residues were present in the tuber at harvest (5). In another study designed to assess the influence of environmental conditions on the rate of microbial degradation of insecticides in soils, temperature had a marked effect on the rate of degradation of chlorpyrifos and chlorfenvinphos. Preliminary results suggested that, under some conditions, soil moisture also will influence the degradation rates of these insecticides in soil (27). Laboratory studies on the persistence and behaviour of the systemic fungicide, metalaxyl, indicated that it was moderately persistent and quite mobile in soil, depending on soil type. Under field conditions it was moderately persistent but remained primarily in the top 30 cm of the soil. No significant residues were present in the watershed draining the area in which metalaxyl had been used (7).

In a study funded in 1981-82 and completed in 1983, data indicated that the half-life of 2,4-D and 2,4-DP in soils in both northern and southern Ontario was < one month regardless of application rate or soil

type (31). In another project associated with pesticide use on turfgrass, laboratory and field studies indicated that <10% of 2,4-D residues were dislodgeable from leaf surfaces, with the remainder of the applied material being bound to the leaf surfaces or translocated into leaf tissue. Rainfall affected the amount of residue recovered, but mowing had essentially no effect on the persistence of dislodgeable 2,4-D on turfgrass. The dislodgeable fraction of the insecticide, diazinon, degraded within one day of application under all conditions tested (20).

A two-year study designed to assess hazards associated with disposal of "empty" pesticide containers in sanitary landfills was completed. Results indicated that: 1) unrinsed pesticide containers can contain hazardous amounts of pesticide residues; 2) rinsing, either using the triple-rinse technique or a rinsing device, generally reduces residues to <0.1% of the original contents; 3) some formulations "settle" out and are difficult to rinse; 4) disposal of pesticide containers at a selected landfill site did not cause contamination of wells drilled in and around the site over the two-year period. During 1982-83, a major effort was made to convince growers of the benefits of rinsing pesticide containers by: publication of the research results; preparation of a factsheet; and presentations at growers' meetings (18).

The potential of pesticides to affect non-target terrestrial and aquatic organisms received further attention. In small plot studies two formulations of carbaryl were evaluated for toxicity to honeybees. Sevin® 80S was toxic to bees, whereas the Sevin XLR formulation had no significant affect (13). In research funded in 1981-82 and completed in 1983, work with 2,4-D in small ponds suggested that it breaks down slowly in small enclosed bodies of water under Ontario climatic conditions. Its impact on non-target microflora was due to removal of the weed-bed ecosystem (29). Laboratory studies on the sublethal effects of atrazine on zooplankton indicated that, under some conditions, atrazine affected the lifespan of individuals and number of young produced/female. These effects were not apparent in field experiments using limnocorrals (12).

OBJECTIVE 3: To reduce total pesticide input into the environment.

Seventeen grants, totalling $172,725 were allocated to this objective.

In recent guidelines for research, OPAC has encouraged development of quantitative data on the economics of pest control. Second-year results of one such study indicated that, in the absence of appropriate control measures, losses due to insects, diseases and weeds were 66.5% ($1,984/ha) and 84.8% ($1,359/ha) for potatoes grown on mineral and organic soil, respectively; 88.8% ($4,744/ha) for rutabagas; and 100% ($4,531/ha) for onions (17).

With development of effective pest monitoring techniques, as or more effective pest control could be achieved with a significant reduction in pesticide use. Eight pest monitoring research projects were funded in 1982-83. Results of a three-year demonstration project indicated that pest management in apples is feasible but that the program will be subject to continued modification to take into account changes in pest complexes, development of resistance to pesticides, available control programs, new application techniques and other technological changes (28). Research on the biology and control of thrips attacking cabbage was supported. Monitoring techniques were devised to identify overwintering sites and seasonal flight patterns. Field tests indicated that properly timed applications of one of several insecticides would provide adequate thrip control. Other results indicated that cabbage varieties varied in susceptibility to thrip attack suggesting that thrip problems could be reduced by greater use of these resistant varieties (16). A proposal to determine if it was feasible to develop a monitoring technique for variegated cutworm attacking tomatoes was supported. Pheromone traps proved as effective as black light traps in monitoring cutworm adults and the degree/day technique proved accurate in predicting peak moth flight (16). Assessment of the feasibility of using pheromones to monitor low populations of spruce budworm in northern Ontario was continued. Different trap designs and commercially available lures were tested for effectiveness. The best of the trap designs can now be recommended for operational use (19). Continued emphasis was placed on development of disease monitoring programs. Research on development of computerized models for timing fungicide applications to onions was continued. A program (BOTCAST) was devised for predicting development of botrytis leaf blight and is being field tested. Development of a model for prediction of downy mildew (DOWNCAST) is nearly complete. In conjunction with this work, fungicides suitable for inclusion in a timed spray program were evaluated (24). Results of a two-year study on the timing and effectiveness of sprays used to control white mold on beans indicated that, with proper timing and coverage, benomyl applied at the recommended application rate resulted in a significant reduction in disease incidence and a corresponding increase in yield (10). In the second year of a study to determine periods of quackgrass interference in soybean development, results indicated that: 1) quackgrass reduced soybean yields; 2) timing of herbicide applications was critical; and 3) graminicide inhibited quackgrass growth at rates lower than current recommendations (6). Research also was supported to determine if it was feasible to estimate weed seed populations present in soil. Emphasis was placed on development of a sampling technique which would provide a reliable estimate of the size of a troublesome weed's seed bank (4).

Current pesticide application techniques leave a great deal to be desired - more efficient application methods would result in better pest control and less environmental contamination. Large quantities of insecticides are applied in Ontario for corn rootworm control but the degree of control achieved is not always satisfactory. A study conducted over the past two years showed that some application equipment was poorly maintained and/or poorly calibrated. More growers were applying less than the recommended insecticide rate than were applying

too much, which suggests that, in part, the poor efficacy seen in cornfields results from inadequate rates (8). Another project designed to determine if it was possible to apply formulated herbicides without mixing in the spray tank was funded. Results indicated that it was possible to meter herbicides and water separately into a modified controlled droplet applicator. Application of herbicides without pre-mixing would have a number of advantages, e.g., insuring that chemicals are stored in their original container and eliminating problems associated with disposal of leftover herbicide-water mixtures (2).

In the longer term, development of non-chemical or integrated pest control methods may be practical in some instances. As noted earlier, some promising results have been obtained in mosquito control studies, using a flatworm, **Dugesia tigrina** as the control agent (30). Considerable emphasis has been placed on development of integrated management techniques for root maggots, with two research programs receiving support in 1982-83. A study was begun to determine if it is feasible to use seed treatments to protect crops such as radish, rutabaga, and onion from root maggot attack, rather than currently recommended soil treatments which involve use of substantially larger quantities of insecticide. Results of this work will be reported in 1984 (25). Support was continued for research to assess the possibility of using native parasitoids as a component in an integrated management program for the onion maggot. Further progress was made in: identifying native parasites and predators of the onion maggot; studying their biology under laboratory and field conditions; improving mass rearing procedures developed for two of the parasitoids; evaluating the toxicity of currently recommended pesticides to two parasitoids. Promising results were obtained in small-scale field trials with parasite releases (26). Experiments to evaluate the effectiveness of the fungus, **Beauvaria bassiana** against seed and cone insects damaging white spruce suggested that it was moderately toxic to spruce cone maggot. Application of spores to white spruce conelets shortly after flowering resulted in a substantial increase in number of sound seeds/cone (9). A study also was initiated to determine if it is feasible to use the egg parasite, **Trichogramma minutum** to control spruce budworm. In a small field plot test, parasite releases resulted in a moderate increase in % spruce budworm parasitism as compared to the control (11). Results of a two-year study to assess the potential of using a naturally occurring smut for suppression of fall panicum, an annual grass which has become a serious weed in corn in Ontario, confirmed the presence of smut-infested fall panicum in all fields examined, with some fields having a high percentage of infested plants. The presence of fall panicum in corn fields reduced weight and height of corn plants and cob weight (1). A proposal also was supported to evaluate the influence of thatch, pH modification and fungicide treatments on snowmold disease in turfgrass. Results of this work will be reported in 1984 (3).

IV. ASSESSMENT

Good progress has been made during the past decade on some of the problems falling within this first research objective. With support from the Ministry of the Environment, research on biting fly biology and control has been highly productive. The biology of important mosquito species has been studied and techniques for locating breeding sites and monitoring for mosquito larvae and adults have been devised. Development of adult and larval control programs to replace organochlorine insecticides has received attention. Pyrethroid insecticides have proven very effective against adults and, at the low concentrations tested, would be unlikely to have detrimental environmental side-effects. Effective organophosphorus insecticides have been registered for use as larvicides and narrow spectrum insect growth regulating chemicals and biological control agents have been tested and show promise for larval control.

Vertebrate pests can be serious problems in urban and rural settings and the Ministry of the Environment has provided support in recent years for research on vertebrate biology and control. Current programs for mouse control in orchards leave much to be desired. Research results suggesting that poison bait feeder stations will provide at least as effective mouse control as the conventional broadcast application of zinc phosphide are encouraging.

The continued erosion in number of available pest control chemicals and discouragingly limited development of new agents is a matter of serious concern to those involved in pest control in agriculture, forestry, and human and animal health. The lack of effective alternatives to restricted chemicals previously applied for weed control in onions and for brush control on rights-of-way are only two examples of problems to come.

Under the second research objective, good progress also has been made during the past decade in defining the fate and behaviour of pesticides in the Ontario environment. Organochlorine insecticide residues are declining and research has shown that organophosphorus, carbamate and pyrethroid insecticides are subject to chemical and microbial degradation in soil and water. Microbial degradation plays a particularly important role and research results which indicate that environmental conditions, such as soil temperature and moisture, influence the rate of microbial degradation of pesticides illustrate the necessity of conducting residue studies on pesticides used in this province under Ontario climatic conditions. In the past OPAC has expressed concern over the fact that some of the newer pesticides or their toxic metabolites tend to be moderately persistent and relatively soluble in water, which suggests that these chemicals might have the potential to contaminate water at dangerous levels. Research being sponsored on the fate and behaviour of aldicarb and metalaxyl mirrors this concern. Results of the research on these and other water soluble pesticidal residues, such as those of phorate and terbufos, suggest that, while these pesticidal residues are mobile in soil, extensive movement does not occur within the context of normal use patterns and

climatic conditions due to the limited persistence of these pesticidal compounds in soil. One aspect of pesticide use which has caused public concern relates to the use of pesticides, especially phenoxy herbicides in public areas, e.g., schoolyards, parks, roadways, etc. Research data have shown that 2,4-D persistence in soils in both southern and northern Ontario is very short and that dislodgeable residues of pesticides, such as 2,4-D and diazinon, used for treatment of turf are negligible within a short time after treatment. Another aspect of pesticide use which has caused public concern is disposal of empty pesticide containers. Research has shown that some unrinsed containers can be hazardous but that, if properly rinsed, they will not constitute a hazard when buried in municipal landfill sites. Results of these research studies should help to alleviate public concern over these questions.

Over the past decade, OPAC has supported research to determine if currently used pesticides will have deleterious effects on non-target terrestrial or aquatic organisms. This research has shown that, in general, environmental side-effects from pesticide use are few and transitory. Research done in 1982-83 to assess possible sublethal effects of atrazine on zooplankton merits mention. In laboratory studies, some sublethal effects were apparent; these effects did not occur under field conditions. This work illustrates the importance of paralleling environmental research in the laboratory with practical field investigations prior to formulating conclusions.

The third research objective, that of reducing pesticide input into the environment, is an important goal. Pesticide use should be justified on the basis of quantitative crop loss data. In the past two years, striking information on damage caused by pests to three crops in the absence of appropriate control measures has been obtained. One of the most promising approaches to reducing pesticide use involves development of pest monitoring techniques to enable proper timing of pesticide applications. Progress made on the eight pest monitoring research projects sponsored in 1982-83, which ranged from feasibility studies to a large-scale demonstration project, illustrated that these techniques have potential. Refinement of pesticide application procedures would also reduce environmental contamination. The discovery that a substantial percentage of growers are not applying recommended dosages of insecticide for corn rootworm control due to poor calibration and/or maintenance of equipment, points to the need for greater emphasis on educating growers as to the importance of proper methods of pesticide application. Integrated methods of pest control are a commendable long-term objective, but it is important to realize that these approaches to pest control will be practical in only a few specific instances. Nevertheless, progress is being made in developing IPM programs for some important pests, such as mosquitoes, root maggots, and the spruce budworm.

The Pesticides Advisory Committee is pleased with the research progress made in 1982-83 and recommends continuation of the program. The committee recognizes that, with the limited funds available, the program can be expected to act only as a catalyst in stimulating support by other agencies for research in the guidelines, for which there is an urgent requirement.

APPENDIX I: FORMAT OF ADVERTISEMENT INVITING APPLICATIONS FOR RESEARCH SUPPORT FROM THE ONTARIO PESTICIDES ADVISORY COMMITTEE.

January, 1982

APPLICATION FOR RESEARCH SUPPORT

The Ontario Ministry of the Environment has a limited amount of funds available for 1982 to sponsor research aimed at: 1) determining potential environmental hazards associated with pesticides currently in use; 2) developing alternative pesticides for those deemed environmentally hazardous and thus restricted in use; and 3) developing alternative approaches to pest control in order to reduce total pesticide input into the environment. Preference will be given to proposals yielding results in a relatively short time with funds being committed on a yearly basis. Research should be in the context of normal use patterns.

The Ministry invites research proposals in the following areas.

1. Economics of pest control including economic threshold levels of pests.*

2. Studies leading to registration of environmentally acceptable pesticides.

3. Reduction of pesticide use through development of effective pest monitoring techniques; alternative integrated or non-chemical methods of control; or improved application techniques.

4. Studies on toxicology, persistence, fate, and biological significance of pesticides in the environment, with particular reference to pesticides widely used in Ontario.

5. Development of information on time which should elapse between dates of treatment and re-entry into treated areas, and on exposure of agricultural workers, licensed exterminators and the public to pesticides.

6. Development of procedures for safe disposal of pesticides and pesticide containers.

7. Residual behaviour of pesticides applied to turfgrass.

APPLICATION PROCEDURE

Research proposals should be submitted to:

The Chairman
Pesticides Advisory Committee
2nd Floor, 1200 Bay Street
Toronto, Ontario M5R 2A5

Applications should include the following:

1. Title of project.
2. Name, address and affiliation of applicant(s).
3. Discussion of problem-- (Applicants applying for continuation of a grant should include a summary of previous progress.)
4. Clear statement of objective(s).
5. Plan for program.
6. Facilities available.
7. Budget - categorize costs as: Personnel - full-time and part-time, equipment, supplies, overhead costs, other.
8. Listing of current projects and other sources of funding.
9. Curriculum vitae on principal investigator(s) (if not already on file with the Pesticides Advisory Committee).

APPLICATIONS SHOULD BE RECEIVED BY FEBRUARY 26, 1982.

* In The Pesticides Act, 1973, S1(1) 20, a "pest" means "any injurious, noxious or troublesome plant or animal life other than man or plant or animal life on or in man and includes any injurious, noxious or troublesome organic function of a plant or animal."

APPENDIX II: RESEARCH PROJECTS SUPPORTED BY THE ONTARIO PESTICIDES ADVISORY COMMITTEE, 1982-83.

No.	Applicant	Location	Project Title	Amount Granted
1.	Alex, J.F.	University of Guelph	Smut of fall panicum	$ 13,500.00
2.	Anderson, G.W.	University of Guelph	The separate metering of herbicides and water to a controlled droplet applicator	5,700.00
3.	Burpee, L.L.	University of Guelph	Integrated management of snow mold disease of turfgrass.	8,000.00
4.	Cavers, P.B.	University of Western Ontario	Monitoring dormant seeds in the soil to predict weed infestations and herbicide needs the following year.	8,800.00
5.	Chapman, R.A. Harris, C.R.	University of Western Ontario	Behaviour of aldicarb (Temik®) in soil.	13,300.00
6.	Dekker, J.	University of Guelph	Weed monitoring techniques for the detection of specific periods of crop interference to reduce or eliminate herbicide usage.	9,000.00
7.	Edgington, L.V.	University of Guelph	The residues of metalaxyl in tobacco plants, soils and in the watershed.	9,000.00
8.	Ellis, C.R.	University of Guelph	Determination of the cause of poor efficacy of insecticides used for control of rootworms.	15,000.00
9.	Fogal, W.H.	Canadian Forestry Service	Evaluating *Beauveria bassiana* for biological control of seed and cone insects in white spruce.	8,000.00
10.	Hall, R.	University of Guelph	Factors affecting the efficacy of sprays to control white mold on white bean.	6,635.00
11.	Hubbes, M. Smith, S.M.	University of Toronto	Feasibility of using the egg parasite, *Trichogramma minutum* for biological control of the spruce bud-worm, *Choristoneura fumiferana* (Clemens).	15,010.00
12.	Kaushik, N.K. Solomon, K.R.	University of Guelph	Evaluation of sublethal effects of pesticides under natural and laboratory conditions.	10,220.00

No.	Applicant	Location	Project Title	Amount Granted
13.	Kevan, P.G. Otis, G.W.	University of Guelph	The assessment of the hazards of formulations of Sevin® (carbaryl) to honeybees, other pollinators, and floral resources in Ontario.	$ 13,500.00
14.	Leili, H.J. Ferguson, G.	H.J. Heinz Co.	Development of a technique for monitoring the variegated cutworm in tomatoes in Essex and Kent Counties to reduce pest damage.	3,500.00
15.	Machado, V.S.	University of Guelph	Efficacy of alternative herbicides to improve onion establishment on muck soils, as a substitute for the loss of allidochlor.	6,000.00
16.	McEwen, F.L.	University of Guelph	Biology and control of thrips on cabbage.	4,680.00
17.	McLeod, D.G.R. Tolman, J.H.	University of Western Ontario	Losses in production of potatoes, rutabagas, and onions attributable to insects, diseases and weeds.	12,000.00
18.	Miles, J.R.W. Harris, C.R.	University of Western Ontario	Development of an acceptable procedure to allow disposal of pesticide containers in sanitary landfills.	6,200.00
19.	Sanders, C.J.	The Sault College of Applied Arts and Technology	Development of sex attractant traps for monitoring changes in low density spruce budworm populations as a means of implementing early intervention management strategies.	11,550.00
20.	Sears, M.K. Stephenson, G.R.	University of Guelph	Dislodgeable pesticide residues on turfgrass foliage in relation to safe re-entry.	16,280.00
21.	Siddiqi, Z.	Chemical Research International	Meadow mouse control in orchards.	17,500.00
22.	Smith, D.W.	University of Guelph	Study of the herbicidal properties and environmental fate of triclopyr.	13,000.00
23.	Surgeoner, G.A.	University of Guelph	Evaluation of adult and larval mosquito sampling techniques in Ontario.	10,000.00
24.	Sutton, J.C. Gillespie, T.J.	University of Guelph	Computerized models for timing fungicides in onions.	16,000.00
25.	Tolman, J.H. Tomlin, A.D.	University of Western Ontario	Feasibility of protecting radish, rutabaga and onion from root maggot damage by insecticide seed treatment.	14,400.00

No.	Applicant	Location	Project Title	Amount Granted
26.	Tomlin, A.D. Tolman, J.H.	University of Western Ontario	Feasibility of using parasites and/or predators in a program of integrated control of the onion maggot	$ 13,450.00
27.	Tu, C.M. Miles, J.R.W.	University of Western Ontario	Influence of environmental factors on the rate of microbial degradation of pesticides in soil.	8,900.00
28.	Wheatstone, W.A. Fisher, P.	Ontario Apple Commission	I.P.M. in Ontario.	7,500.00
	TOTAL			$ 296,625.00

APPENDIX III: PROGRESS REPORTS (ABSTRACTS) ON PROJECTS FUNDED BY THE ONTARIO PESTICIDES ADVSIROY COMMITTEE, 1982-83.

1. Alex, J.F. and Brisson, P.L. - *Competition of fall panicum in corn and and incidence of fall panicum smut.*

In the summers of 1981 and 1982 several fields in southwestern Ontario were examined for the presence of fall panicum and natural occurrences of the fall panicum smut. In 1981 from 16% to 54% of plants in each field were smutted. In 1982, the percentage infection within comparable fields ranged from 25 to 70%. The one field having 54% infection in 1981 was re-examined in 1982 and found to have 65% of plants smutted. In every field examined in both years, including those in which detailed counts were not taken, smut-infected fall panicum was present.

In Guelph, field studies of the competitive effects of smutted versus non-smutted fall panicum plants in field corn were attempted. Disease-free fall panicum seed was sown at three densities: 150, 50 and 10 plants/m^2. The presence of fall panicum caused apparent reductions in weight of the total corn plant, weight of the cob, and height of corn. A comparison of the competitive effects of smutted and non-smutted fall panicum was attempted by using two methods of infecting the fall panicum seed with smut. In the first method the panicum seeds were dusted with smut spores before seeding into the corn plots. In the second method suspensions of smut spores were hand sprayed on the field plots. Up to 7% of the fall panicum plants were smutted in the second method, but none were smutted in the first method.

2. Anderson, G.W. - *Separate metering of herbicides and water to a controlled droplet applicator.*

The application of herbicides without the requirement of pre-mixing with water in a spray tank could have a number of possibilities for the reduction of environmental contamination. For instance, it would help insure that chemicals are stored in their original containers and remove some of the problems of disposal of unsprayed herbicide-water mix. This research was conducted to determine if formulated herbicides could be metered directly into a controlled droplet applicator and be distributed uniformly enough to provide weed control at least as good as that provided by present methods of application.

These studies were conducted with a Micro-max (Micron Corporation, Houston, Texas) controlled droplet applicator. The applicator was modified by removing the stationary inner cone and by drilling an extra hole in the applicator to allow placement of herbicide delivery orifices. Water was delivered through the standard orifices on the applicator and 1800 r.p.m. was used for all the studies. Preliminary studies were conducted indoors to determine the proper orifice sizes for delivery of the specific herbicides as a steady stream at the low volumes required. Since a single orifice was used for each herbicide, it was anticipated that the herbicide would not be issued uniformly around the perimeter of the spinning cone. A number of trials were conducted to determine the position of the chemical delivery orifice which would produce the most desirable pattern as the disk moved forward. Since air pressure instead of a positive displacement pump was used to move the

herbicide, extra attention had to be given to the temperature at time of calibration and spraying. The uniformity of distribution of the herbicide was assessed by measuring the pattern with a patternator and observing plots in the field.

In one field trial, glyphosate was applied to quackgrass foliage at rates of 0.5, 1.0 and 1.5 kg/ha with rates of 0, 20 and 40 ℓ/ha of water separately metered. The same rates of glyphosate were also applied with fan type nozzles deliverying 40 ℓ and 200 ℓ of spray solution. In a second trial, bentazon - 1.0 kg/ha and TF 1169 - 0.2 kg/ha were each metered separately, alone or simultaneously with separately metered water at a rate of 20 ℓ/ha. The same rates of these herbicides were applied with fan type nozzles deliverying 200 ℓ/ha of spray mix. This study was done on a 30 cm high stand of soybeans and annual weeds.

Results indicate that it is not necessary to tank mix water and herbicide, but they can be separately metered into a Micro-max controlled droplet applicator. The use of this method on a commercial basis would however, require the development of specific chemical formulations or the use of low-capacity positive displacement pumps to move the herbicide. Further work is required to select the best method for holding the chemical delivery orifices in place, distributing the chemical uniformly through small diameter lines and providing small fast acting control valves at the units.

3. Burpee, L.L., and Goultry, L.G. - *Integrated management of snow mold disease of turfgrass.*

Experiments were designed to evaluate the influence of thatch pH modification and fungicide treatments on the incidence of snow molds on creeping bentgrass cv. Penncross and annual bluegrass.

Thatch pH modification. Turfgrass thatch, a layer of organic matter that develops between soil and green shoots and leaves, serves as a niche for survival of several species of plant pathogenic fungi. The thatch layer may range from 2 to 8 cm in depth and frequently, it is found to be 2 to 10 times more acidic than the corresponding subsoil. This lower pH contributes to a relatively slow microbial degradation and it may also influence the efficacy of pesticides and the survival of turfgrass pathogens.

Grey and pink snow molds were selected as models to test the influence of thatch pH modification on disease incidence and severity. Field plots were established at Barrie, Ontario (annual bluegrass golf course fairway), Shanty Bay, Ontario (creeping bentgrass golf green), and Cambridge, Ontario (creeping bentgrass research site). Treatments included applications of sulfur (1.0 + 2.0 kg/100 m^2), ammonium sulfate (0.24 + 0.48 kg/100 m^2), aluminum sulfate (30.5 + 61.0 g/100 m^2), ferrous sulfate (30.5 + 61 g/100 m^2), ammonium bicarbonate (0.21 + 0.42 kg/100 m^2), calcium carbonate (0.44 + 0.28 kg/100 m^2), and a non-treated control. Treatments were arranged in a randomized complete block design with four replications. Each treatment plot measured 1 x 9 m. At Barrie and Shanty Bay, applications were made at ca 30 d intervals from June 30 to September 30. The Cambridge site was treated at ca 14 d intervals from July 8 to October 14.

Portions of the pH modification plots were superimposed with fungicides at dosages ca 0.7 times those recommended for control of snow molds.

Fungicide treatments included chloroneb (109 g AI/100 m^2), a combination of mercurous and mercuric chloride (12.24 + 24.5 g AI/100 m^2), and quintozene (135 g AI/100 m^2). At Barrie and Shanty Bay, applications were made on October 28. The Cambridge site was treated on November 9. The plots will be evaluated for snow mold incidence and severity in April, 1983.

Thatch and soil samples were removed from the plots prior to applying the fungicide. Analyses revealed that all treatments resulted in significant (P = 0.05) changes in thatch pH at the Cambridge site. Less variation was observed among samples taken from Barrie and Shanty Bay. The lime treatments produced the only significant (P = 0.05) changes in soil pH.

Fungicide evaluations. Fungicides are commonly used to control snow molds on fine turf areas in Ontario. However, the number of effective chemicals is limited by the long residual activity that is necessary to control these fungi under months of snow cover. Unfortunately, the effective fungicides include potentially hazardous organic and inorganic mercury compounds and PCNB. The present study was designed to evaluate potentially less-hazardous fungicides for control of snow molds and to determine if the use of a fungicide adjuvant would increase the residual activity of snow mold fungicides. On November 9, twenty-four fungicide treatments were applied to creeping bentgrass at Cambridge, Ontario. Treatments were arranged in a randomized complete block design with four replications. Four treatments were designed to test the effect of a fungicide adjuvant (Exhalt 800) on fungicide efficacy. The plots will be evaluated for snow mold incidence and severity in April, 1983.

4. Benoit, D.L., and Cavers, P.B. - *A comparison of sampling techniques for estimating seed populations in arable soil.*

The seed bank of an arable soil is the major source of annual weed infestations in cultivated fields. Although many studies have been made to estimate seed populations in soils, little attention has been paid to sampling procedures. Consequently, a study was initiated to determine the type of sampling pattern as well as the number of samples needed to best typify a seed population of a single weed species in arable soil. The study site near Mount Elgin in Oxford County, Ontario, was a corn field with a previous history of infestation by triazine-resistant *Chenopodium album* L. A 108.5 m^2 area was randomly located within the field and sampled systematically at 3.5 m intervals (1024 soil samples). Sampling was done at the end of July with a soil sample of 1.9 cm diameter to a 15 cm depth. After collection, the samples were soaked in a hexametaphosphate and sodium bicarbonate solution (2:1) to disperse soil particles. These samples were then washed with a fine spray of water over a series of sieves. The residues were dried on filter paper and the seeds were later extracted under a dissecting microscope. The total number of seeds and the number of *Chenopodium* spp. (mostly *C. album* but could include a few of other species of *Chenopodium*) were recorded in two data matrices. From these matrices three sampling patterns - random, systematic and cluster - will be compared in their estimation of the seed population mean (μ). The minimum number of soil samples needed to describe both the seed bank of a single genus (*i.e., Chenopodium* spp.) and the total seed bank will also be calculated. From these results an efficient sampling technique which can give a reliable estimate of the size of a troublesome weed's seed bank will be recommended.

5. Chapman, R.A. and Harris, C.R. - *Behaviour of aldicarb (Temik®) in soil.*

The project was a continuation of the one funded in 1981. In the laboratory, the leaching of aldicarb and its metabolites from mineral and organic soil treated with granular aldicarb under the watering conditions comparable to those used in the watered portion of the 1981 and 1982 field studies was examined. The uptake of aldicarb and its metabolites by potatoes grown in pots of treated mineral soil was also examined. A field study on the persistence of aldicarb in mineral and organic soils was carried out for a furrow application (1981 study was of a broadcast application) and included the artificially induced high and low soil moisture conditions examined in 1981. The uptake of aldicarb by potatoes was also examined in the field.

In the laboratory, aldicarb was much more mobile in the mineral soil than in the organic soil. The application of the equivalent of 135 mm of "rain" over 10 days leached 80% of the applied aldicarb under conditions where 28% of the applied water passed through the 15 cm soil layer. The leached material was 60% aldicarb and 40% a. sulfoxide. In contrast, only 30% of the treatment could be leached from the organic soil with 450 mm of "rain" over 42 days with 26% of the applied moisture passing through the soil. The material leached from the organic soil was 70% a. sulfoxide and 30% a. sulfone. The composition of the leached material is consistent with the more rapid disappearance of aldicarb from the organic soil previously observed both in the laboratory and field and also demonstrates the effect of soil type on the chemical composition of residues resulting from the application of aldicarb. The high mobility and lower rate of transformation of aldicarb in the mineral soil are of particular interest given the greater stability of aldicarb in water relative to its metabolites.

The field studies on the persistence of furrow applications showed the same dependence of persistence on soil moisture and/or watering as was observed previously with broadcast applications, *i.e.*, most persistent in dry soil. The relative contribution of degradation and movement to the overall persistence could not be determined. The persistence of the total residue (aldicarb + a. sulfoxide + a. sulfone) from broadcast and furrow applications was similar for the organic soil but the furrow application was more persistent in the mineral soil.

Both aldicarb and a. sulfoxide were rapidly taken up in high concentrations by the potato seed piece growing under laboratory conditions. For potted mineral soil treated with granular aldicarb at a rate equivalent to 3.36 kg AI/ha (51 cm row spacing) the seed piece contained ca. 100 ppm of aldicarb and 25 ppm a. sulfoxide after 1 week and ca. 30 and 60 ppm, respectively, after 3 weeks. The amounts taken up were roughly proportional to the treatment rate at 0.5x and 2x this treatment. High concentrations (ca. 75 ppm) of a. sulfoxide and much smaller amounts of sulfone were observed in the first foliage sampled at 4 weeks and the level declined only slightly during the experiment. In the field, aldicarb concentrations reached a maximum in the seed piece at 70 ppm in 3 days for the mineral soil and 30 ppm in 1 week for the organic soil and declined to <0.5 ppm in 6 weeks. Aldicarb sulfoxide concentrations in the seed piece maximized at 40 and 25 ppm in 2 weeks for the mineral and organic soils, respectively, and declined only slightly over the next 4 weeks. The foliage contained a. sulfoxide and much smaller amounts of a. sulfone. Maximum concentrations of a. sulfoxide were observed in the first foliage sampled at 2 weeks (11 ppm) for organic soil and 3 weeks (26 ppm) for mineral soil and these declined to <1 ppm by 10-12 weeks. New tubers contained only aldicarb

sulfoxide with concentrations of 3.8 ppm at 6 weeks and <0.2 ppm at 14 weeks for the mineral soil and 2.4 ppm at 5 weeks and <0.1 ppm at 14 weeks in the organic soil. The results show that, particularly in mineral soil where aldicarb and its metabolites are present at appreciable concentrations for only 1-2 weeks, the toxicant reaching the foliage comes largely from the reservoir absorbed by the seed piece during that time. Maximum effectiveness of aldicarb treatments will be achieved under conditions where the transfer to the seed piece is maximized.

6. Dekker, J.H. and Sikkema, P. - *Weed monitoring techniques for the detection of specific periods of crop interference to reduce or eliminate herbicide usage.*

A field study was conducted, during 1981 and 1982 at the Elora Research Station, Elora, Ontario, on the effects of quackgrass (*Agropyron repens*) on soybeans (*Glycine max*) and the usefulness of infrared thermometry in predicting critical periods of weed interference. The study consisted of three experiments: serial weed removal to ascertain time of weed induced stress periods; high fertility and irrigation to reduce competitive effects; and daily infrared thermometric monitoring of soybean leaf temperatures for remote detection of interference due to water stress.

Soybean seed yield was substantially reduced due to quackgrass interference. In addition, soybean shoot dry weight, leaf number, height, and pod numbers were reduced. Soybean seed protein content and seed weights were both increased due to quackgrass interference.

High levels of phosphorus and potassium fertility did not overcome the quackgrass interference. A major portion of the competitive effects of quackgrass could be alleviated by additional soil moisture, but the soybean seed yield for the irrigated treatment was still lower (16%) than the weed-free control.

Using infrared thermometry, the first occurrence of a critical quackgrass induced water stress was recorded during the soybean flowering stage, when the quackgrass was in the four leaf growth stage. This coincided with the time of first significant soybean yield losses. Subsequent quackgrass removal did not result in growth and yield recovery to the level of the weed-free control. Soybean shoot dry weight and leaf tissue nutrient concentration of nitrogen and phosphorus also indicate that the interference effects commenced around this period of time.

There was a highly significant reverse relation between accumulated stress degree days and soybean yield reduction due to quackgrass interference. This implies that the use of the stress degree day concept may be a valuable tool in predicting degree of soybean yield losses due to quackgrass interference.

Several field and controlled environment experiments were conducted to determine: 1) if soybean yield losses are incurred by delaying treatment of quackgrass from the 3 to the 5 leaf growth stage; 2) whether very low, sublethal, rates of the tested herbicides have the potential to suppress growth and, 3) if this information could be used to develop a practical, agronomic, management system of reduced pesticide usage that

would result in soybean yields at or above the economic threshold. Several new postemergence applied graminicides were tested including BAS 9052, TF 1169, DOWCO 453, NCI 96683, RO 13-8895 and HOE 736. Several conclusions can be made from these studies: 1) delay in treatment of quackgrass from the 3 leaf to the 5 leaf growth stage results in yield losses; 2) graminicide rates as low as 15% of possible field recommended rates were shown to strongly inhibit quackgrass shoot and rhizome growth subsequent to treatment under ideal growth room conditions; 3) preliminary field evaluations of graminicide rates as low as 67% of possible field recommended rates led to no soybean yield losses at harvest; and, 4) refinement of these management practices could result in further reductions of several of these new herbicides for the suppression of quackgrass growth at or below the economic threshold of yield losses.

7. Sharom, M.S. and Edgington, L.V. - *The mobility and dissipation of metalaxyl in tobacco soil under laboratory and field conditions.*

In 1982 metalaxyl was temporarily registered as a systemic soil fungicide to control blue mold of tobacco in Ontario. There was concern that this fungicide may be leached deep enough to contaminate ground water and carry-over of metalaxyl residues in the following year may enter the surrounding watershed as soil-fungicide complex. The adsorption of metalaxyl on tobacco soil, collected from the Delhi Research Station, and sediment from Big Creek was compared with three other pesticides. Results indicated that permethrin was adsorbed more than pyrazon > metalaxyl > 2,4-D. The soil had a higher adsorptive capacity than the sediment. Mobility of the chemicals in soil TLC plates indicated 2,4-D and metalaxyl > pyrazone > permethrin. Studies on the effect of rainfall on metalaxyl mobility indicated that the fungicide is very mobile with 9, 73 and 86% of the applied amount being leached through the 25 cm soil column after being subjected to 10, 15 and 20 cm of simulated rainfall, respectively. The influence of sequential periods of rain and drying (65°C for 24 or 48 hr) on the mobility of metalaxyl was determined by applying from one to four 5 cm increments of simulated rainfall on 25 cm soil columns. The results indicated that the fungicide was leached with each rainfall but moved upward during the drying cycle. There was no leachate from soil columns that were subjected to alternate rainfall and an 8 hr drying cycle. However, approximately 33% of the applied metalaxyl was leached through the column that received four increments of 5 cm of rainfall alternated with 24 hr drying cycle after each rainfall. Field plot studies indicated that most of the soil-incorporated metalaxyl remained in the upper 0-30 cm. Approximately 10% of the fungicide was leached into the 30-45 cm zone. The half-life of metalaxyl in soil from field plots and six growers farms ranged from three to five weeks. Metalaxyl acid, a possible metabolite, was not detected in any of the soil samples. Metalaxyl and its acid were not detected in either the water or sediment of Big Creek.

8. Ellis, C.R. - *Contribution of faulty application and inadequate rates of granular insecticides to poor control of corn rootworms.*

A random group of corn growers were contacted during planting to inspect their equipment for applying granular insecticides and to determine application rates. Of 51 farmers contacted, 49 or 96% participated in the survey. Of these, 10 or 20.4% were not using insecticide. In fact, all

farmers planting first-year corn were not using insecticide, whereas all farmers planting corn following corn, were.

More farmers were applying less than the recommended rate than were applying too much. The median was 90% of the recommended rate and 13% of equipment was applying less than 80% the recommended rate. Moreover, some equipment which was applying approximately the recommended rate, had enough variation between application to result in some rows receiving less than 80% of the recommended rate. The difference between maximum and minimum rates for the applicators on a particular planter was over 20% of the mean rate on 50% of the equipment tested. These data indicate that part of the poor efficacy seen in fields results from inadequate rates. The major cause of inadequate rates was failure to calibrate the year of application.

The survey also showed that equipment was less than optimal. Spreaders were used on 91.8% of equipment but 5.7% of these had one or more spreaders missing. Wind protection was used on only 10.8% of equipment and devices for incorporation on only 24% of equipment.

Insufficient attention has been given to discrepancies between recommended techniques for pesticide application and actual farmer practice. These discrepancies have obvious implications for pest management and particularly extension education.

9. Fogal, W.H. - *Evaluating Beauveria bassiana for biological control of seed and cone insects in white spruce.*

A method of producing spores of *Beauveria bassiana* and procedures for testing, maintaining and improving inoculum quality have been developed for use at Petawawa National Forestry Institute. Sufficient quantities of spores of desired quality can be produced for laboratory and small-scale field experiments and quality of commercial preparations for large-scale field testing can be determined.

Preliminary investigations of two modes of applying spores for control of seed and cone insects have been completed. Application of spores to white spruce conelets shortly after flowering resulted in a 37 percent increase in numbers of sound seed per cone. Studies on application of spores to soil for control of spruce cone maggot have been facilitated by development of laboratory and field bioassay systems. The bioassay systems are based on a survey undertaken to determine the horizontal and vertical distribution of cone maggot puparia around the base of cone bearing trees. Puparia are found within a one meter radius around the tree base and are confined to the litter and A-horizon layer of soil in white spruce stands. Tests of a spore preparation containing 7.3×10^7 spores per gram under laboratory and field conditions have been undertaken to determine effects of spore carrier (talc or flour) and effects of soil moisture content (low or high) on efficacy. Spore levels of 4 or 8 kg (spores) per ha formulated as 5 g inoculum per kg of talc or flour were tested. The highest level of control, at 67 percent, was achieved in low moisture soil using flour as the spore carrier.

10. Morton, J. and Hall, R. - *Factors affecting the efficacy of sprays to control white mold on white bean.*

Field scale spraying to control white mold on white beans was carried out at two locations, Downie Townships & Fullarton, in Ontario in 1982. A recommended fungicide (benomyl) was applied at the rate of 2 kg/ha to the plots as a treatment. The purpose of the experiment was to relate coverage of the plants with fungicide to disease control. Coverage was measured by bioassaying sprayed blossoms for the presence or absence of fungicide. Sprays were more effective when applied in the last week of July than the second week in August. A significant increase in coverage of the blossoms resulted in a significant decrease in disease incidence and an accompanying increase in yield. One hundred percent coverage of the blossoms kept disease levels below 15% (no spray - 95% disease) and resulted in a doubling of yield due to disease reduction. This good coverage was affected by the use of high volumes of water in both types of sprayers used in the trial. The 550 ℓ H_2O/ha needed for disease control is generally more water than is normally used, at present, in Ontario. Higher rates of water in the sprays would appear to be one effective way to control white mold, and consideration should be given to this in future recommendations.

11. Hubbes, M. and Smith, S.M. - *Feasibility of using the egg parasite, Trichogramma minutum Riley, for biological control of the spruce budworm, Choristoneura fumiferana Clemens.*

Ground releases of *Trichogramma minutum* were carried out on 8 and 14 July 1982 in Hearst, Ontario. Taking into consideration emergence and sex ratio, approximately 60,000 female parasites were released on an area of 0.25 hectares. Sentinel egg masses, placed in the field and changed at 3-day intervals from 21 June to 17 August, were used to monitor parasitism.

Natural parasitism, in the control plots, was low throughout the season, ranging from 0 to 4% of the egg masses. Maximum parasitism following the first release was 11%, while that following the second release was 19%. Egg masses in plots which received both releases or 120,000 female *Trichogramma* per 0.25 hectares averaged a maximum of 16% parasitism. Doubling the number of parasites released, therefore, under field conditions, did not double the level of parasitism. At the time of the first release, the weather was unusually cold and rainy and the effect of timing on the level of parasitism could not be determined.

Within 3 days of release at ground level, 70% of the *Trichogramma* females had moved into the upper third of the canopy where the majority of spruce budworm egg masses are laid. Horizontal dispersal, 10 to 20 meters outside the release areas, was also observed, 2 to 3 weeks following the releases.

Sleeve cages in the field indicated that a number of release conditions affect the level of parasitism. Greater parasitism of spruce budworm egg masses was observed: 1) on white spruce compared to balsam fir; 2) when honey was supplied to female parasites compared to no energy source; 3) as the density of egg masses increased; 4) as the parasite density increased; and 5) when the rearing temperature of the parasites was greater than 17°C.

Preliminary laboratory studies were initiated to determine biological and electrophoretic differences between 6 geographical strains of *Trichogramma minutum*. No differences in longevity or fecundity were found, however, electrophoretic variation was observed for the esterase enzyme system. Further work on biological characteristics and other enzyme systems remains to be done, as well as an attempt to correlate isozyme variation with biological characteristics. If possible, this could be used in the rapid identification of those strains of *Trichogramma minutum* with the greatest potential for biological control of the spruce budworm.

12. Kaushik, N.K., Solomon, K.R., Stephenson, G., and Day, K. - *Assessment of sublethal affects of atrazine on zooplankton.*

A research program is currently investigating the use of large aquatic enclosures or limnocorrals as a suitable method for assessing the impact of and recovery from a pesticide contamination of aquatic ecosystems. To supplement this field research, a laboratory study, funded by the Ontario Pesticides Advisory Committee, was initiated to investigate possible effects of sublethal concentrations of atrazine on zooplankton life history parameters.

In one set of experiments, *Daphnia magna* contained in cups were observed daily to determine the effects of low atrazine (LA) concentration of 0.2 mg/ℓ and high atrazine (HA) concentration of 2.0 mg/ℓ on fecundity and longevity. Such observations were made on individuals from 6 generations. The average number of young produced per female in *D. magna* individuals exposed to atrazine for 21 days (a standard chronic exposure experiment used to predict life cycle results) did not differ from the controls in generations 1, 2, and 3; however in generations 4, 5, and 6 the LA and HA treatments significantly reduced the number of young produced. The *D. magna* individuals exposed to atrazine for their entire lifespan showed that only the HA treatment significantly reduced the average number of young produced per female, the mean value for controls being 160.5 as against 69.9 for HA treatment. There was no effect of atrazine on time to first brood (maturation time). Individuals exposed to atrazine lived longer (LA - 46 d, HA - 51 d) than the controls (41 d) in this cup experiment.

In another set of experiments approximately 20 *D. magna* individuals were placed in a 4 ℓ aquarium containing water from treated and untreated corrals. Observations were made twice weekly to obtain results comparable to those from the cup experiment. The number of young produced per individual over the average lifespan in the HA treatment (75.2) was significantly lower than that in the controls (271.89). However, unlike the cup experiment, the average lifespan of individuals exposed to atrazine was significantly reduced.

Analyses of field samples did not show a significant numerical difference at the species level between the controls and atrazine-treated corrals. Therefore, mean dry weight estimates of four dominant zooplankton species (*Bosmina longirostris*, *Ceriodaphnia lacustris*, *Diaptomus oregonensis*, and *Mesocyclops edax*) were used as indicators of growth and biomass. However, dry weight estimates of individuals from treated and untreated corrals did not differ significantly.

The number of eggs per individual and the percentage of ovigerous females in the population were determined for two zooplankton species from preserved samples collected from the treated and untreated limnocorrals. No ovigerous female *Diaptomus oregonensis* were found in samples from the HA-treated limnocorrals. Atrazine did not affect the number of eggs per individual in *Ceriodaphnia lacustris*, however the percentage of ovigerous females in the population increased. This finding is important as it may explain why cladoceran zooplankton do not show a numerical decline when exposed to atrazine. Although the number of young produced is reduced, there may be more female individuals producing young.

13. Kevan, P.G. and Otis, G.W. - *Hazards of formulations of Sevin® (carbaryl) to honeybees and other pollinators in Southern Ontario.*

New formulations of Sevin (carbaryl) insecticide, XLR, UCSF25, have a sticker which causes the material to adhere to plants upon drying. This is thought to reduce the hazard to foraging bees as they pick up and contact less of the active ingredient.

Sevin XLR and 80S were applied to small plots of blooming rape. These were then enclosed in screen tents (10x10x8') into each of which a small (1 super) hive of bees was introduced. The mortality of the adult bees was monitored. The experiment was conducted twice. Sevin 80S was found to cause the highest mortality whereas XLR and the unsprayed control were similarly little affected. Analysis of nectar and pollen collected by the bees in the tents is in progress.

Field experiments were conducted in ca. 10 acre plots in tassling corn and in ca. 8 acre plots of mixed pasture containing a high proportion of alfalfa in bloom. Individual fields received aircraft applications of Sevin XLR and 80S, or remained untreated. A fourth plot of corn was treated with UCSF25. The results are not clear because it rained heavily within 48 hrs and 12 hrs respectively of the insecticide applications, and the insecticide was washed off the vegetation.

14. Leili, H.J. and Ferguson, G. - *Development of a technique for monitoring the variegated cutworm in tomatoes in Essex and Kent Counties to reduce pest damage.*

Pheromone trapping proved to be as reliable and effective as black light trapping for monitoring variegated cutworm. Optimal pheromone trap height was found to be 1 to 2 feet above the foliage canopy. Location characteristics and location of pheromone traps, within the field, were important factors influencing number of moths trapped.

A celcius-degree-day model, developed by D.E. Simonet *et al.*, Ohio Agricultural Research and Development Centre, proved very accurate in predicting peak moth flight activity. However, no concrete correlations between moth populations and subsequent larval populations could be found in 1982.

15. Machado, V.S. - *Efficacy of alternative herbicides to improve onion establishment on muck soils, as a substitute for the loss of allidochlor.*

Two replicated herbicide trials were carried out on organic soil at the Muck Research Station, Bradford. The cultivar 'Rocket' (Asgrow) was direct seeded in both trials, immediately followed by a preemergence application of paraquat. In trial Onion I, three broadleaf herbicides were tested as single applications namely cyanazine (loop stage), oxyfluorfen (2 true-leaf stage) and ioxynil (3 true-leaf stage). Each of these broadleaf herbicides was tested at a single rate, in combination with each of the following grass herbicides, diclofop methyl, fluazifop, pendimethalin, HOE 00736, CGA 82725 and BAS 9052 resulting in 18 treatment combinations. In trial Onion II, repeat applications of the three broadleaf herbicides were tested, with a time interval of 2 weeks between applications.

Single applications of ioxynil were not effective in controlling late germinating weeds, as compared with cyanazine and the prolonged residual control noted with oxyfluorfen. However, oxyfluorfen at 0.25 kg/ha stunted the onion plants recording 44% crop phytotoxicity, as compared to 19% with cyanazine and less than 9% with ioxynil. Repeated applications of ioxynil proved more promising with late germinating weeds, but could only be applied 'late' postemergence at the 3 true-leaf stage. Lower concentrations of oxyfluorfen applied 'early' postemergence followed by a later application of ioxynil, do merit future testing. All the grass herbicides tested did not indicate any significant crop phytotoxicity.

Laboratory experiments involving osmoconditioning onion seeds with polyethylene glycol, significantly accelerated emergence at low temperatures. Onion seeds initially osmoconditioned and later air dried, were stored at 4°C for various periods up to 4 weeks, with no subsequent loss in germination ability. The optimum concentrations of polyethylene glycol and pre-germination treatment periods for onion seeds were worked out.

16. Annette, G.W. and F.L. McEwen - *Biology and control of thrips on cabbage.*

Thrips have been reported as a pest on cabbage in southern Ontario during the past few years. The discolouration due to feeding damage and presence of thrips in cabbage has resulted in rejection of cabbage for processing. As a result of grower concerns, a research project was initiated to study the biology and control of this pest.

Monitoring of overwintering sites, alternate hosts and seasonal abundance was carried out at the Simcoe Horticultural Research Station. Monitoring of thrips on cabbage treated with various insecticide regimes and on cabbage varieties comprised the control trials.

Using 1981 overwintering site monitoring results, a detailed system was designed to determine possible sources of thrips infestation. Various crop and weed species were examined for thrips species found on cabbage. Data indicate that mixed vegetation on railway and roadside right-of-ways, winter wheat, sweet clover, orchard grass, red clover, oxeye daisy, and asparagus harbour thrips found on cabbage. Thrips from several other weed and crop species are to be identified and may reveal other host plants.

Sticky board monitoring has revealed that seasonal flight patterns are quite variable, however, some general trends are evident. The first thrips have been caught during the last week of May and they have been most abundant from mid-July until mid-September after which time the flying population drops dramatically.

Based on 1981 data, parathion, dimethoate and fenvalerate were chosen for 1982 testing. The spray program was started prior to cabbage head formation. In previous years applications were made every 10 days, resulting in 7 to 8 sprays per season. It was therefore decided that each compound be applied on a 7 and 14 day schedule to determine whether or not the number of sprays during a season could be reduced.

The results indicate that dimethoate, parathion and fenvalerate were effective on a 7 day schedule, providing 91%, 86% and 88% reduction of thrips within the cabbage head, respectively. Extending the spray schedule to 14 days reduced control by 5 to 14% with fenvalerate providing 83%, dimethoate providing 77% and parathion providing 77% reduction.

During the 1981 season there were indications that cabbage varieties varied in their susceptibility to thrips infestation. Therefore a trial was designed to look specifically at the thrips population on 5 varieties of cabbage.

The varieties were Genese Hy-Dry, Hinova, Hitoma, Round-up, and Sanabul. The average number of thrips inside the head were Hinova 13.4, Sanabul 11.7, Hitoma 11.0, Genese Hi-Dry 3.8, and Round-up 3.1, indicating there is a difference in susceptibility among cabbage varieties.

Results of these trials indicate that thrips infesting cabbage come from numerous weed and crop species and thrips are abundant from mid-July through mid-September during which time cabbage is an acceptable host.

Control programs utilizing dimethoate, parathion or fenvalerate on a 7 to 14 day schedule beginning before head formation will reduce the population in cabbage. The utilization of less susceptible varieties could also contribute to the prevention of thrips becoming a serious pest.

17. McLeod, D.G.R. and Tolman, J.H. -*Losses in production of potatoes, rutabagas and onions due to insects, weeds and/or diseases.*

Once again in 1982, in order to estimate potential yield losses that could be expected by vegetable growers, a total of four trials were established at three locations in the London area. For each crop, the five treatments (0, IFH, FH, IF, IH) were replicated four times in a randomized complete block design.

Potatoes

i - Strathroy
Kennebec potatoes were planted in a sandy loam near Strathroy on May 17. Moderate stands of lambsquarters developed in herbicide-free plots; lower populations of ragweed, yellow nutsedge, quackgrass and smooth crabgrass were observed. Horsetail was not controlled by applied herbicides. The low population of Colorado potato beetle was not well controlled by furrow applications

of Disyston 15G. The most important insect pest was potato leafhopper. The first hopperburn was noted on July 23; by September 9 vines in untreated plots were completely dead. A few lesions of early blight were observed in fungicide-free plots on August 20 but disease was not a serious problem. Potatoes were dug October 1-4 and subsequently washed and graded. Results were as follows:

Source of Loss	Program Applied	Average Marketable Yield (tonnes/ha)	%[i] Yield Loss	Value Per Hectare ($112.50/t)	Loss[i] Per Hectare ($)
-	IFH[ii]	26.43	-	$2,985.27	-
Insects	FH	15.12	*42.8	1,707.80	1,277.47
Weeds	IF	22.47	15.0	2,537.99	447.28
Diseases	IH	25.32	4.2	2,859.89	125.38
In, W, D[iii]	0	8.86	*66.5	1,000.74	1,984.53

* - $p<0.05$
i - loss relative to complete IFH program
ii - I-insecticide; F-fungicide; H-herbicide
iii - In-insects; W-weeds; D-diseases

ii - Thedford
Superior potatoes were planted in organic soil on the Thedford-Grand Bend Marsh on May 31. Dense stands of pigweed, barnyard grass and lady's thumb developed quickly in herbicide-free plots; purslane and large crabgrass appeared in all plots. Application of Temik 10G in the seed furrow did not provide adequate control of the generally low population of Colorado potato beetle; two applications of Belmark 30EC were required. The most serious insect pest again proved to be the potato leafhopper. Hopperburn was observed in insecticide-free plots by July 26 and vines had virtually collapsed by August 19. The first lesions of early blight were noted in fungicide-free plots on July 27, were widespread in these plots by August 19 and had begun to develop in fungicide-free plots on August 12 but did not become a problem in any plot. A 6.7 cm rainfall on August 2 flooded the site, leaving plots under water for several hours and accounting for the generally low yields at this site. Potatoes were dug September 8 and subsequently washed and graded. Results were as follows:

Source of Loss	Program Applied	Average Marketable Yield (tonnes/ha)	%[i] Yield Loss	Value Per Hectare ($112.50/t)	Loss[i] Per Hectare ($)
-	IFH[ii]	14.25	-	$1,603.13	-
Insects	FH	7.29	*48.9	820.13	783.00
Weeds	IF	4.18	*70.7	470.25	1,132.88
Diseases	IH	6.83	*52.1	768.38	834.75
In,W,D[iii]	0	2.17	*84.8	244.13	1,359.00

* - $p<0.05$
i - loss relative to complete IFH program
ii - I-insecticide; F-fungicide; H-herbicide
iii - In-insects; W-weeds; D-diseases

Rutabagas

Laurentian rutabagas were planted in a sandy clay loam at the Fanshawe Research Station on May 26. Although stands were somewhat uneven, substantial populations of ragweed and old witchgrass developed on herbicide-free plots; lesser populations of perennials were also noted. Although significant aphid populations were recorded throughout the summer no aphicides were applied. Similarly, since plants had grown 6-8 leaves by the time peak populations of crucifer flea beetles developed, no specific control was undertaken. Drenches were applied three times in an attempt to minimize cabbage maggot injury. Disease was never a problem after rutabaga emergence. Rutabagas were pulled September 16 and subsequently graded. Results were as follows:

Source of Loss	Program Applied	Average Marketable Yield (tonnes/ha)	%[i] Yield Loss	Value Per Hectare ($116.55/t)	Loss Per Hectare ($)
-	[ii]IFH	45.84	-	$5,341.49	-
Insects	FH	19.87	*56.6	2,315.85	3,025.64
Weeds	IF	25.52	*44.3	2,974.36	2,367.13
Diseases	IH	50.15	+9.4	5,844.98	+503.49
In,W,D	0	5.12	*88.8	596.74	4,744.75

* - $p<0.05$
i - loss relative to complete IFH program
ii - I-insecticide; F-fungicide; H-herbicide
iii - In-insects; W-weeds; D-diseases

Onions

Rocket onions were planted in organic soil on the Thedford-Grand Bend Marsh on April 30. Dense stands of barnyard grass, pigweed, lady's thumb, large crabgrass and purslane totally covered herbicide-free plots by June 14; onions were choked out by July 7. Onion maggot adults were first trapped May 12, reached peak levels the week of May 24 and completed three generations by the end of September. High populations of thrips did not develop in insecticide-free plots until August 30. The first lesions of Botrytis were observed June 17; fungicide applications controlled disease development until heavy rains on August 2 created ideal conditions for a disease epidemic. Further fungicide application slightly slowed disease development; by August 30, disease was severe in all plots. Onions were pulled September 14, harvested September 21 and subsequently cleaned and graded. Results were as follows:

Source of Loss	Program Applied	Average Marketable Yield (tonnes/ha) #1 Sm.	#1 Reg.	%[i] Yield Loss	Value[ii] Per Hectare ($)	Loss[i] Per Hectare ($)
-	IFH[iii]	10.58	23.10	-	4,531.12	-
Insects	FH	4.53	24.53	13.7	4,516.60	14.52
Weeds	IF	0.00	0.00	*100.0	0.00	4,531.12
Diseases	IH	9.42	19.98	12.7	3,930.96	600.16
In,W,D[iv]	0	0.00	0.00	*100.0	0.00	4,531.12

* - p 0.05
i - total loss relative to complete IFH program
ii - #1 Small-44.00/t; #1 Regular-176.00/t
iii - I-insecticide; F-fungicide; H-herbicide
iv - In-insects; W-weeds; D-diseases

Useful data were collected for all three crops in 1982. The situation in onions, however, was less clear this year. Weeds continue to be a limiting factor in onion production. Due to dry weather in May the furrow insecticide, however, did not provide adequate protection against damage by the overwintering generation of the onion maggot. Also the fungicide program could not withstand the very heavy disease pressure in August. Growers on the marsh experienced similar problems.

18. Miles, J.R.W. and Harris, C.R. - *Development of an acceptable procedure to allow disposal of pesticide containers in sanitary landfills.*

The report of January 1982 was in the form of a slide presentation which showed the events of the pesticide container disposal project and analysis of rinsates of containers, listing the amounts of residuals expressed as percent of original contents.

During 1982 our slide presentation on "Pesticide Container Rinsing and Disposal" was presented on:-

March 9, at the Thedford-Grand Bend Vegetable Growers Day at Thedford, Ontario.
April 13, at Ontario Ministry of the Environment Staff Meeting, Kempenfeldt Training Centre, Barrie, Ontario.
May 20, at 14th Eastern Canada Pesticide Residue Seminar, Moncton, New Brunswick.
October 12, at Canadian Agricultural Chemicals Assoc. Ontario Section, Cambridge, Ontario.

Two magazine articles entitled, "New Device for Rinsing Pesticide Containers" resulted from interviews. These were published in:-

"Canadian Fruitgrower" - February 1982, p. 25 and
"Cash Crop Farming" - March 1982, p. 35.
A third article appeared in "Report on Farming," August 1982.

An exhibit was prepared for the International Plowing Match at Lucan, September 29 - October 2 in cooperation with the Ontario Ministry of the Environment. The centerpiece of the exhibit was a transparent (plexiglass) 5-gallon drum with a Jet Rinse inserted, and a continuous stream of water being pumped through to demonstrate the use of the Jet Rinse with pesticide containers.

A paper entitled, "Assessment of Hazards Associated with Pesticide Container Disposal and of Rinsing Procedures as a Means of Enabling Disposal of Pesticide Containers in Sanitary Landfills" was submitted to the Journal of Environmental Science and Health for publication.

The study of residual pesticides in "empty" rinsed and non-rinsed containers was continued by regular collection and analysis of containers put aside by cooperating growers. A set of rinses from Randox containers was analysed by chemists at OMAF Residue Laboratory, Guelph. The remainder of the rinses were analysed at this laboratory. Most of the residuals were <0.1% of original contents, but some of the individual containers held hazardous amounts (30 to 56 g) of parathion. As in 1981, a number of 1-gallon plastic containers which had held "Furadan Flowable" were examined and found to contain various amounts of "paste" and "cake" residues.

Attempts have been made to analyse the plastic of "Furadan Flowable" containers for possible adsorption of carbofuran. Interfering compounds co-extracted from the plastic have prevented accurate analysis. This study is being continued.

Water samples from the test wells at the Watford Landfill Site were analysed. No detectable levels of pesticides which had been deposited in the site during 1981 were found.

19. Sanders, C.J. - *Development of sex attractant traps for monitoring changes in low density spruce budworm populations.*

In 1980 attempts to correlate trap catch with larval population densities were confounded by saturation of the sticky surfaces of the traps. In 1981 it was found that this problem could be overcome, at least at lower densities, by using less potent lures. Alternatively, non-sticky funnel traps could be used which have a much higher capacity, and which can be used over a wider range of population densities.

The 1982 experiments involved more extensive testing of these alternative trap designs, and a thorough evaluation of different commercial lures. Traps were deployed in 23 areas across northern Ontarion in stands with populations of spruce budworm ranging from less than .1 larvae per/branch to more than 20 larvae per/branch. As before, the sticky traps with regular strength lures were all saturated, but, with the lower strength lures, traps remained unsaturated at population densities below 2.5 larvae per/branch with maximum catches ranging from 22 per trap at lowest densities to 606 per trap at the highest, with a correlation coefficient of 0.77.

Other experiments in 1982 were designed to determine attributes of the different trap designs, such as deterioration of trapping efficiency over time and possible repellent effects caused by the killing agents used or by previously captured moths. However no serious problems were encountered.

The best of these designs can therefore now be recommended for operational use.

Four lures were compared for effectiveness, three of which are commercially available. Two of the three commerical formulations performed well, but release rates of the attractant were very different, making comparisons difficult. The third commercial formulation gave very poor catches although chemical analysis suggested that release rates were adequately high. Further work is therefore indicated before a definitive recommendation can be made on which lure should be adopted for operational use.

20. Sears, M.K. and Stephenson, G.R. - *Dislodgeable pesticide residues on turfgrass foliage in relation to safe re-entry.*

a) Thompson, D.G., Bowhey, C.S., Stephenson, G.R., Sears, M.K., and Braun, H.E. - *Distribution of 2,4-D and diazinon applied to turfgrass growing under controlled conditions.*

Diazinon and 2,4-D are two of the most commonly applied chemicals in turfgrass maintenance programs. As such they are environmental contaminants and there may be some risk of human exposure in public areas. The most probable exposure route for humans following application of these chemicals is through dislodgement and subsequent dermal adsorption.

Laboratory studies have been conducted utilizing transplanted turfgrass (*Poa pratensis*) grown under controlled environmental conditions. The objectives of these studies were to determine the distribution of 2,4-D and diazinon through the leaf-surface, leaf tissue, thatch and soil at various times following application of commercially formulated products at typical field rates (1.0 kg AI/ha and 4.5 kg AI/ha, respectively).

Vigorous wiping of leaf surfaces with moistened cheesecloth, washing the leaf tissue with various solvents and extracting mascerated tissue and soil provided samples which were subsequently analyzed for chemical residues. Analysis was performed utilizing gas-liquid chromatography with electron capture detection of 2,4-D and n/P flame photometric detection of diazinon.

The greatest proportion of 2,4-D residues remained on the surface of the leaf blades (Fig. 1). Increasing amounts became bound to the surface or were translocated into the leaf tissue. An unexpected result was the persistence of the dislodgeable fraction which remained constant over the duration of the experiment.

Diazinon residues were much shorter lived (Fig. 2). Dislodgeable fractions were significant for only 6 hours after application, and significant total residues were recovered only up to 3 days after application.

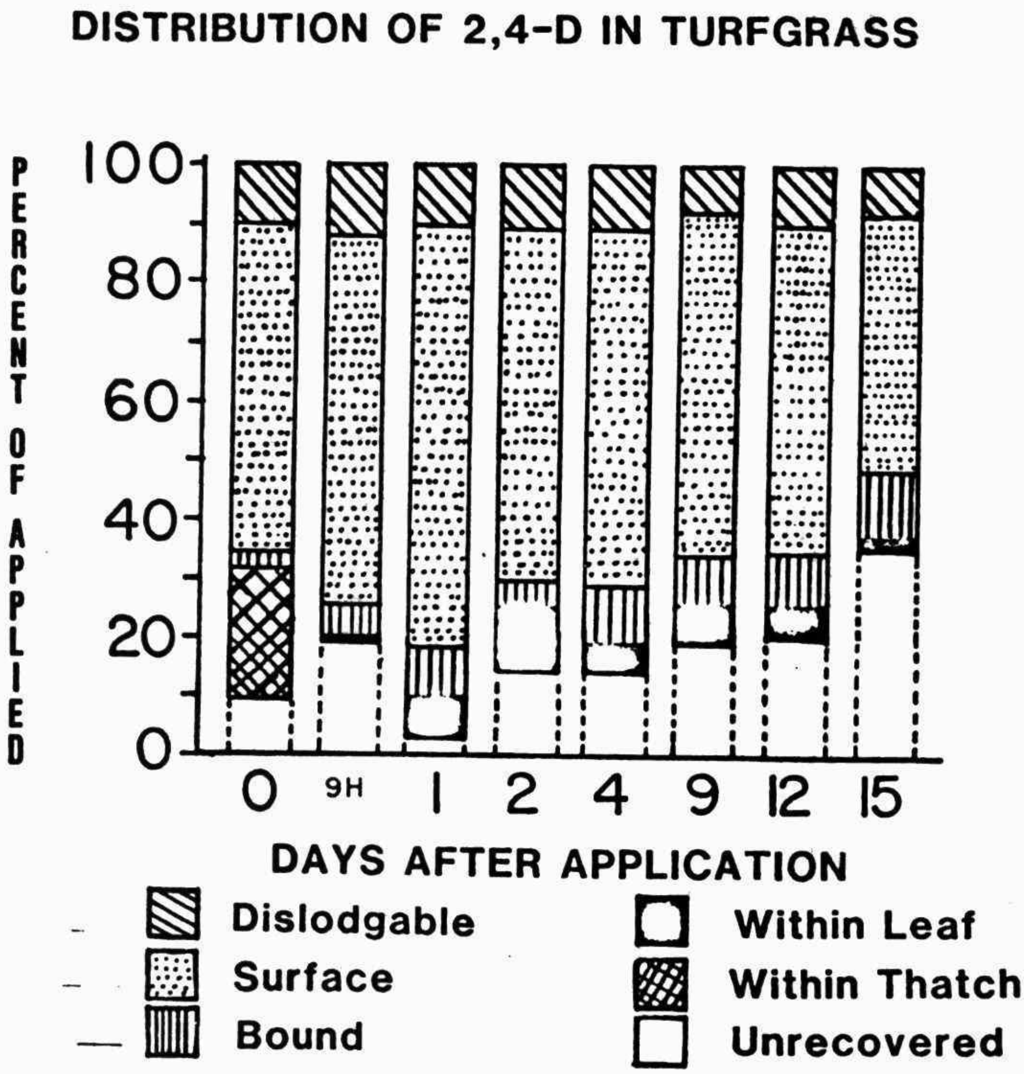

Fig. 1. Distribution and persistence of 2,4-D residues on turfgrass maintained in a controlled environment.

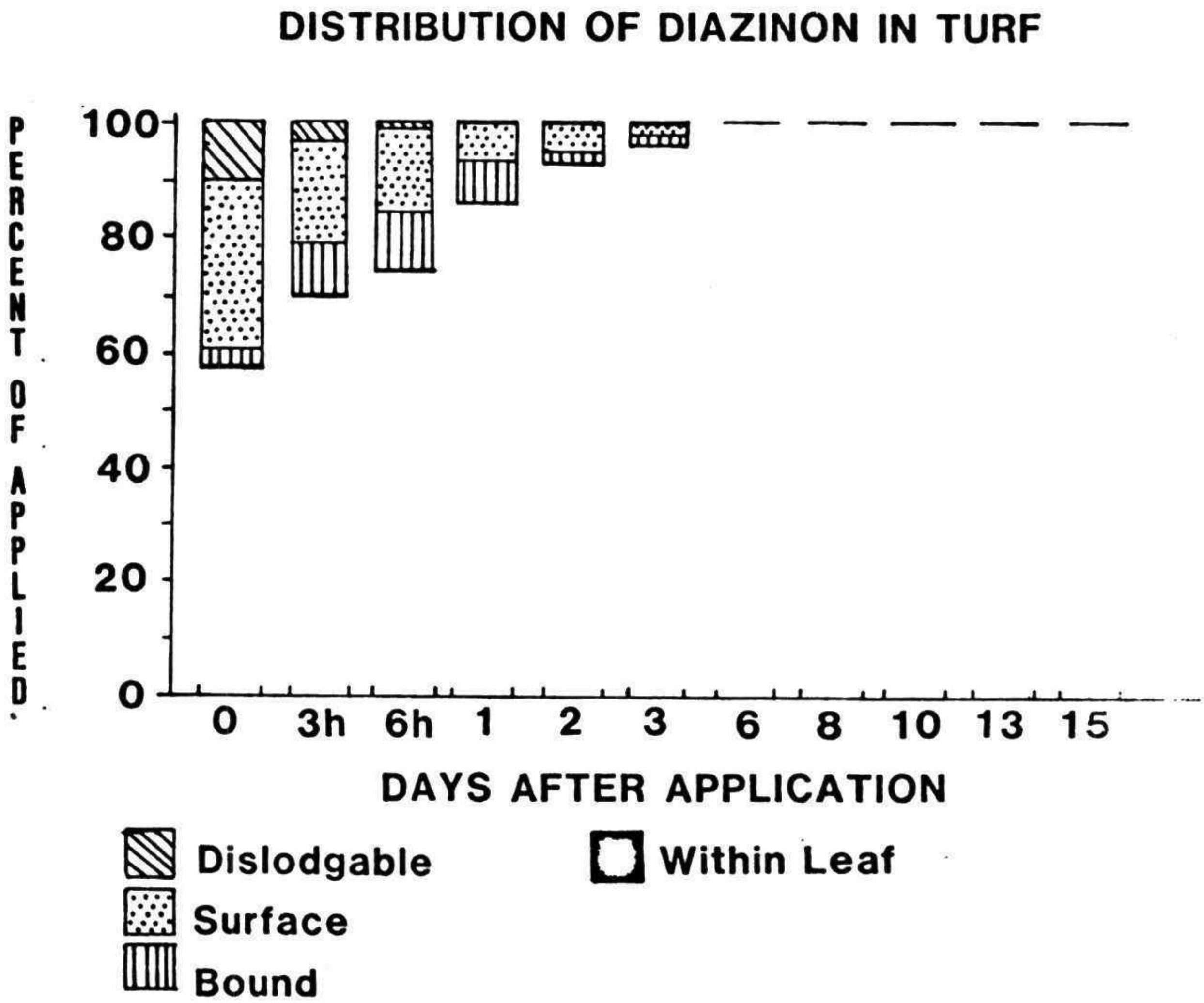

Fig. 2. Distribution and persistence of diazinon residues on turfgrass maintained in a controlled environment.

b) Thompson, D.G., Stephenson, G.R., Sears, M.K. and Bowhey, C.S. - *Dislodgeable residues and persistence of 2,4-D following application to turfgrass.*

Recent criticism of the use of 2,4-D for weed control in parks and school yards has led to discontinuation of its use in some areas. The need for suitable re-entry times into sprayed areas has been suggested. Information regarding the persistence of residues on turfgrass surfaces is lacking.

A series of experiments were conducted to determine the longevity of dislodgeable surface residues of 2,4-D following application to turfgrass (*Poa pratensis*) under typical field conditions of southern Ontario. Dislodgeable residues were estimated by vigorous wiping of 1 m^2 areas with moistened cheese-cloth. Analysis of sample extracts was performed using gas-liquid chromatography with electron capture detection of the methyl ester derivative of 2,4-D.

Results indicated that less than 5% of material applied on a mass basis is easily dislodgeable at zero time. Of the material originally applied, less than 1% was dislodgeable after five days and only 0.003% after eleven days.

Rainfall had a significant effect on reducing the amount of residue recovered (Fig. 3). Less than 0.05 mg/m^2 were recovered after a heavy rainfall of 1.8 cm. Mowing had essentially no effect on the persistence of dislodgeable 2,4-D on the turfgrass (Fig. 4).

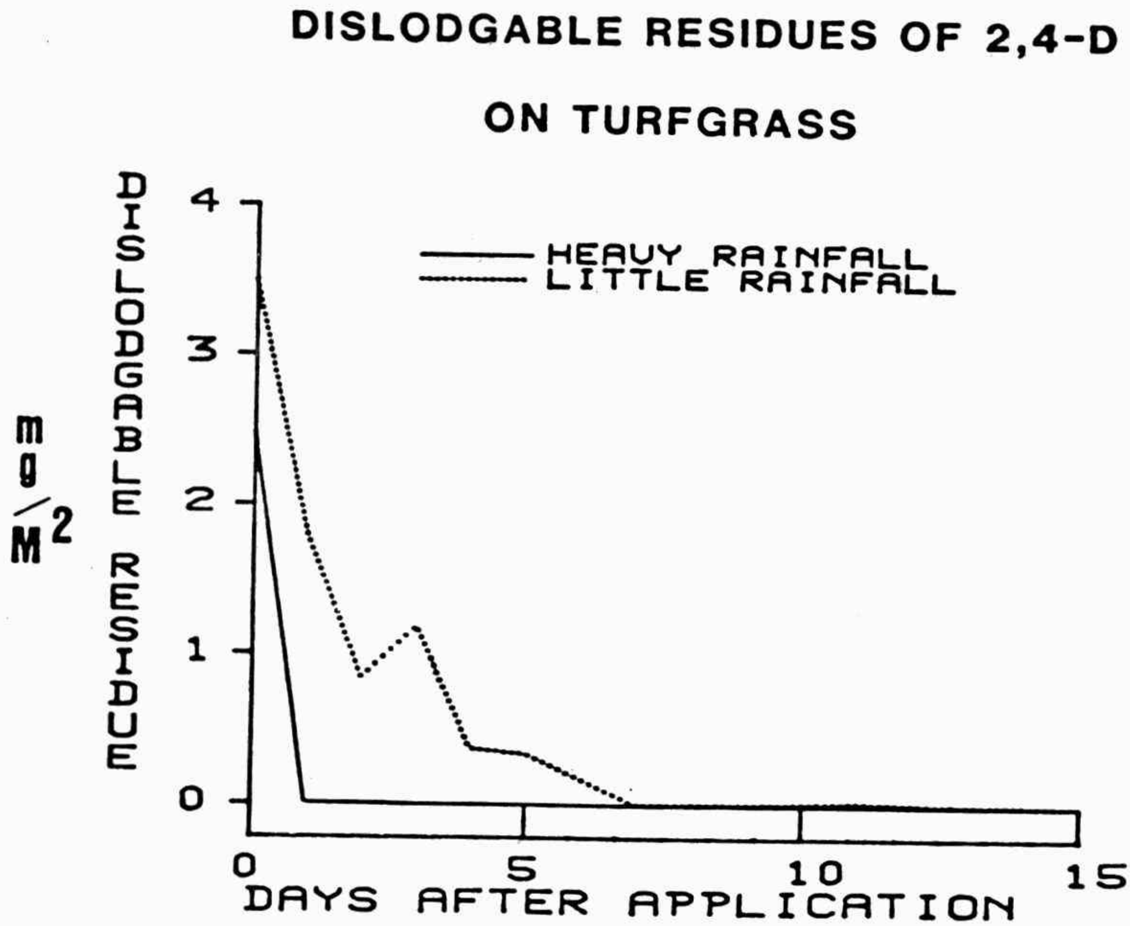

Figure 3. Dislodgeable residues of 2,4-D applied to turfgrass under conditions of heavy rainfall (1.8 cm following application) and of little rain-fall.

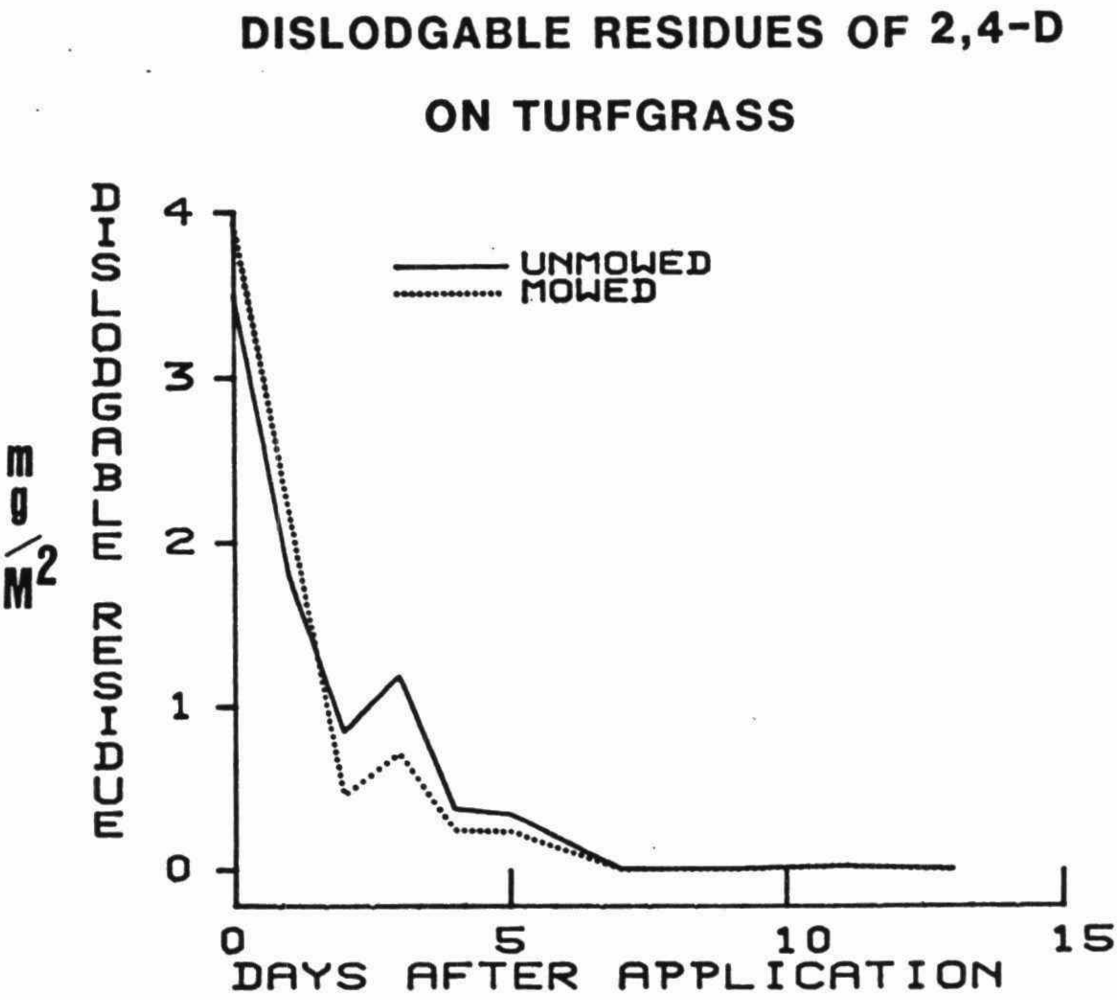

Fig. 4. Dislodgeable residues of 2,4-D applied to turfgrass. One-half of the replicates were mowed (arrows) while the others were left unmowed.

c) Sears, M.K., Bowhey, C.S., Thompson, D.G., Stephenson, G.R., and Braun, H.E. - *Dislodgeable residues and persistence of diazinon following application to turfgrass.*

Diazinon, at approximately 5 kg AI/ha, was applied to plots of bluegrass turf and the dislodgeable portion was sampled by walking on the plots using cloth coverings over boots. Samples were taken on the initial day of application and at daily intervals up to 2 weeks following application. The effects of rainfall and of mowing the turfgrass on the degree of dislodging was examined. The dislodgeable fraction of diazinon applied to turfgrass degraded rapidly (within one day) under all conditions tested in the fields (Figs. 5 & 6). The total insecticide recovered from the cloths immediately following application was 14-20 $\mu g/cm^2$ (Tables 1, 2, 3). This represents 100-350 times less than the acute dermal LD_{50} to white rats.

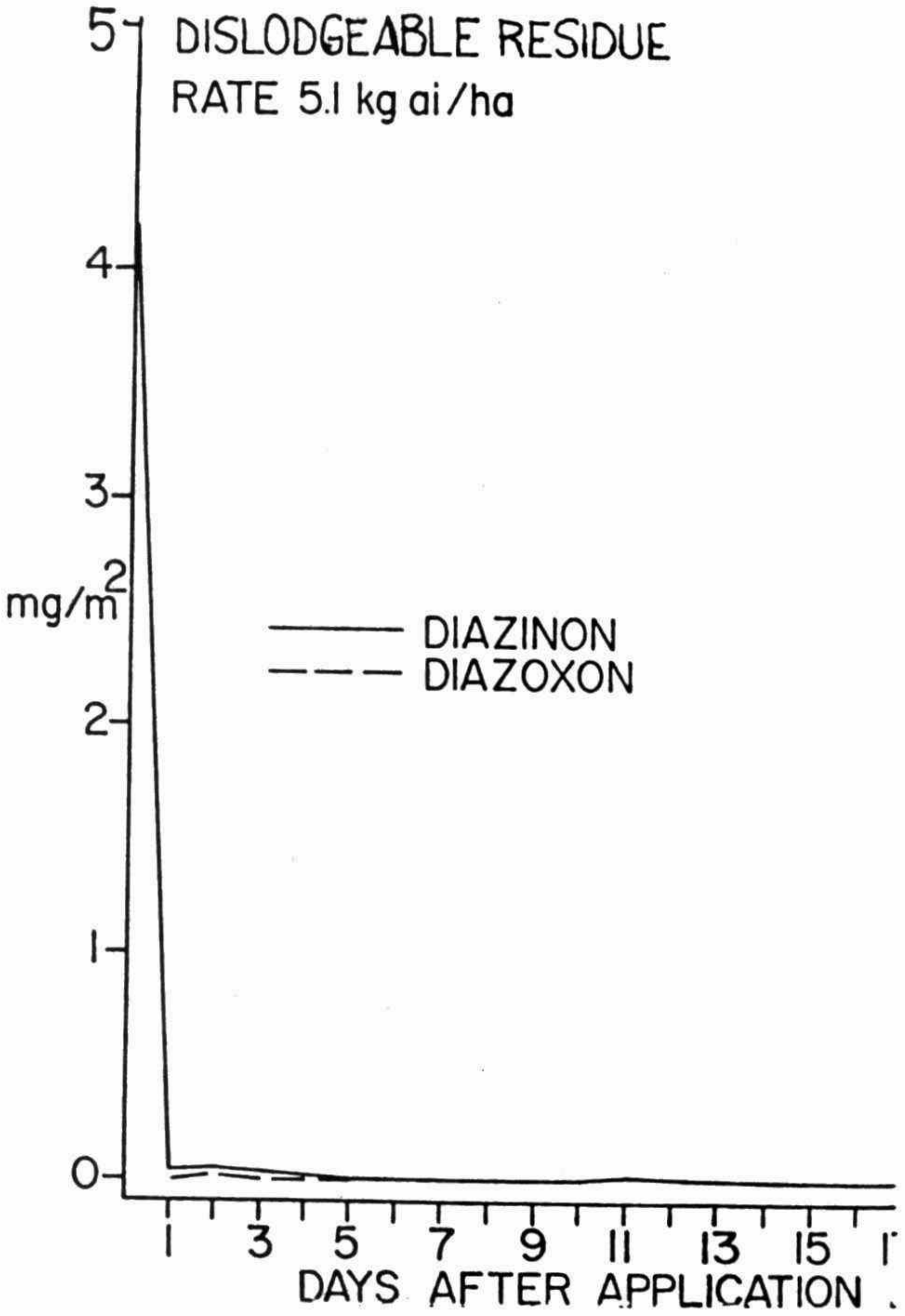

Fig. 5. Dislodgeable residues of diazinon applied to turfgrass under conditions of heavy rainfall (1.8 cm following application).

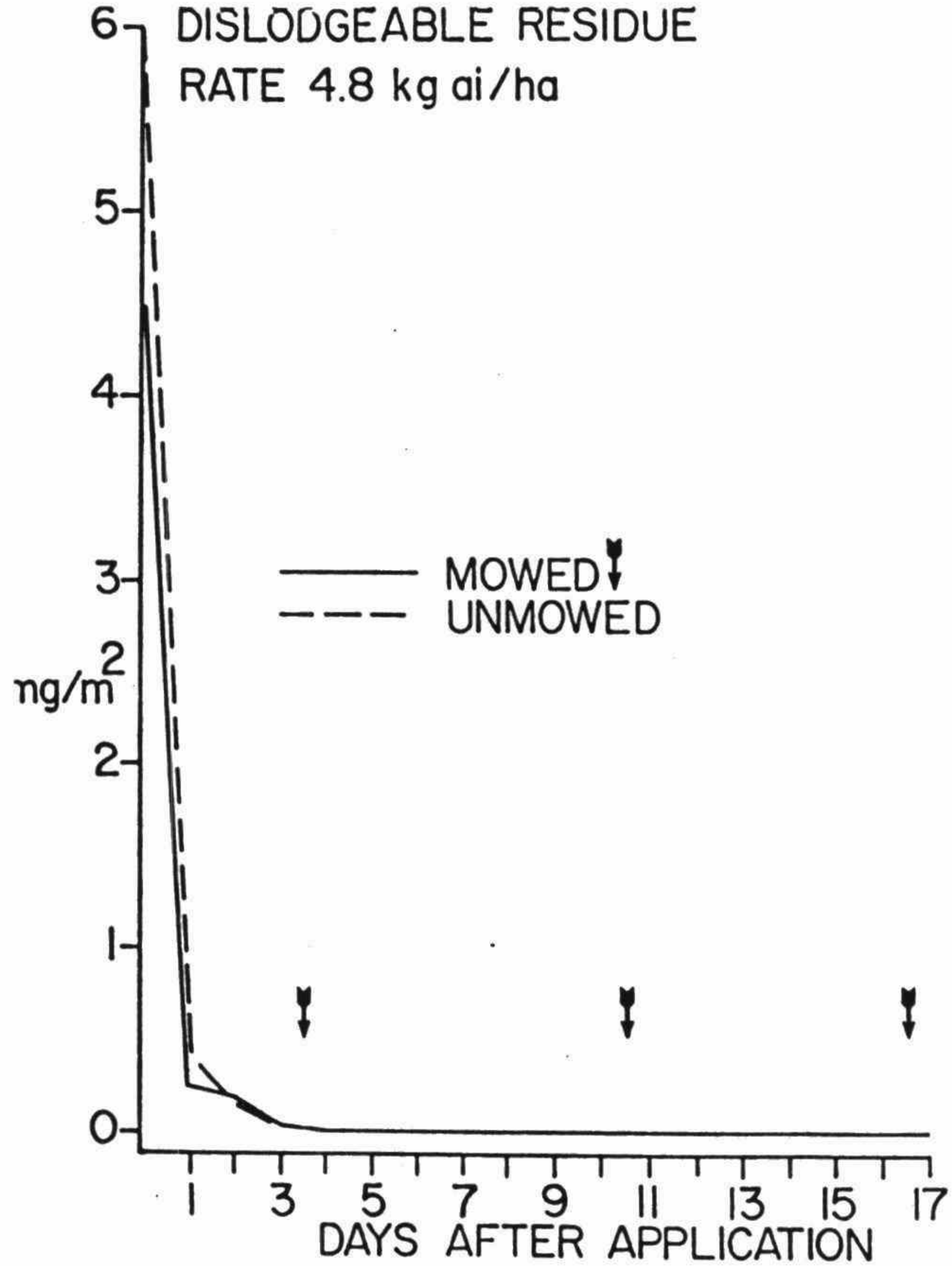

Fig. 6. Dislodgeable residues of diazinon applied to turfgrass in which half the replicates were mowed and half were not mowed.

Table 1.

Dislodgeable diazinon
Rainfall
5.13 kg AI/ha applied

Days post-appl.	μg/m² Turf Diazinon	μg/m² Turf Diazoxon	μg/m² Turf Total	μg/cm² Cloth Total
0	4167	-	4167	13.9
1	37	2.6	40	0.1
3	31	4.5	36	0.1
5	13	4.2	17	0.1
7	6	2.2	8	<0.1
11	3	1.7	5	<0.1
15	0.5	0.3	0.8	<0.1

Table 2.

Dislodgeable diazinon
No rainfall - Not mowed
4.75 kg AI/ha applied

Days post-appl.	μg/m² Turf Diazinon	μg/m² Turf Diazoxon	μg/m² Turf Total	μg/cm² Cloth Total
0	5991	-	5991	20.0
1	412	-	412	1.4
2	158	14.1	172	0.6
3	22	1.1	23	0.1
7	11	1.0	12	<0.1
10	5	0.4	5	<0.1
17	2	0.5	2	<0.1

Table 3.

Dislodgeable diazinon
No rainfall - Mowed
4.87 kg AI/ha applied

Days post-appl.	μg/m² Turf Diazinon	μg/m² Turf Diazoxon	μg/m² Turf Total	μg/cm² Cloth Total
0	4483	<0.4	4483	14.9
1	246	1.3	247	0.8
2	183	7.2	190	0.6
3	30	0.8	31	0.1
7	24	0.8	25	0.1
10	9	0.4	9	<0.1
17	6	<0.4	6	<0.1

21. Siddiqui, Z. - *Meadow mouse control in orchards.*

In 1981 this long term study was initiated at four orchards to evaluate the effectiveness of a poison bait feeder station, using anticoagulant rodenticides, to control meadow mice as compared to the conventional broadcast of zinc phosphide.

The meadow mouse population in the experimental plots was estimated by live trapping in fall 1981, in spring 1982, and again in fall 1982. Tree girdling by mice was recorded in spring 1982. The bait stations were cleaned and bait replenished in spring and fall 1982.

A sharp decline in the mouse population was observed in spring 1982, from levels recorded in fall 1981, in all the treatments. The population increased in fall 1982 but not to the levels of fall, 1981. There were more mice in the broadcast treatment than the bait station treatments. The various anticoagulants in the bait stations did not show any noticeable differences in terms of number of mice. Tree girdling data reflected similar findings where the broadcast treatment had more girdling than the bait station treatments.

Further observations will continue in spring and fall of 1983 to conclude the evaluation of the poison bait stations for a long term meadow mouse control in apple orchards.

Various groups of apple growers have shown interest in using this method of meadow mouse control.

22. Jotcham, J.R. and D.W. Smith - *Study of the herbicidal properties and environmental fate of triclopyr.*

Research was initiated to determine some environmental properties of triclopyr (Garlon®), a brush-control agent not yet registered for use in Canada.

Residues: An old-field site was chosen under an Ontario Hydro right-of-way near Milton. Triclopyr (ester) was applied at 8 ℓ/ha (3.84 kg/ha AI) using a Pestex backpack sprayer at 30 psi (2109 g/cm^2). Three plots, each 2 x 10 m were treated. At regular intervals after spraying (-1, 0, 1, 3, 7, 14, 28, and 56 days), vegetation and soil samples were collected for residue analysis. Residue analyses are being done by Dow Chemical Canada (Sarnia). One extra sample of both soil and vegetation were collected every sampling date, and sent to the Ontario Provincial Pesticide Residue Testing Laboratory (Guelph). The residue analyses from the latter indicate that the level of triclopyr in the vegetation samples was 340 ppm immediately after spraying. One day after treatment, 50% of the herbicide was present. Ten percent was found after 14 days, and about 1% after 56 days. In the soil, the peak herbicide level was 0.5 ppm, obtained immediately after spraying the plots. This was only 0.15% of the peak residue found in vegetation, and was 11% of the residue level found in vegetation after 56 days. Degradation in soil was much slower than that in the vegetation. After 14 days, 32% of the peak residue level in the soil was present, and about 4% was found after 56 days. The more complete analyses from Dow Chemical were not yet available at the time of writing this report.

Soil persistence: Field plots were set out at the Elora Research Station to test the comparative persistence of triclopyr, picloram, and 2,4,5-T using bioassay methods. Spraying was performed in a similar manner to that for the residue studies at Milton, and soil samples (15 cores, each 2.5 x 15 cm, from each plot), were collected at the same intervals as for the residue studies and frozen immediately after collection. Three rates were used: 3.48 kg/ha, 0.384 kg/ha, and 0.0384 kg/ha AI. There were 5 replicates for each treatment. Sampling will continue throughout the next growing season and terminate in the fall of 1983. The soil samples will then be thawed and used for greenhouse studies, probably with soybeans, sugar maple, and white ash as the bioassay species.

Soil mobility: Soil mobility and adsorption are currently being studied using soil (sandy loam) from the Milton site and three soils (sandy podzol, clay, and organic muck) from sites approximately 80 km east of Timmins, Ontario. Both intact soil columns and prepared soil columns will be used with radioactive labelled triclopyr, picloram, and 2,4-D. Initial results, using 40 mm diameter intact soil columns from the Milton site, show that adsorption is largely determined by the depth of the organic horizon and by the amount of rainfall. The top organic layer (5-15 cm thick) adsorbs 80-95% of the applied triclopyr, after artificial rainfall (distilled water at 2.5 cm/hr) equal to 5 cm, and about 50% after 10 cm of rain. Once past the organic horizon, adsorption is much less. The columns are 25 cm long, and 'rainfall' of 5 cm causes 5-10% of the applied triclopyr to move right through the columns, to be collected with the leachate. Ten cm of rain results in about 25% of the herbicide moving through the column. These studies will be compared to mobility in soil thin-layer chromatographs, using the same compounds.

Plant responses: This aspect of the funded research has not yet started. Using the same radioactive labelled compounds as for the soil studies, translocation and site of action will be examined using sugar maple, white ash, white spruce, and balsam fir as test organisms.

Efficacy: Triclopyr is being compared with a 2,4-D/2,4-DP formulation at a site along the Ontario Hydro right-of-way at Milton. All species, woody and herbaceous, were inventoried before treatment. The site will be studied for two more years to determine the influence of these herbicides on the direction and rate of succession.

23. Surgeoner, G.A. - *Evaluation of adult and larval mosquito sampling techniques in Ontario.*

a) Copps, P.T. and G.A. Surgeoner - *Habitat distribution of mosquitoes in southern Ontario with an assessment of adult trapping techniques.*

Females of 21 mosquito species, representing 5 genera were collected by 7 different trapping techniques in 3 habitats at Guelph, Ontario in 1981 and 1982. A total of 62,050 females and 5,881 males were taken in suction, New Jersey light, dry-ice-baited CDC, quail and pigeon-baited Ehrenberg, rabbit-baited, mouse-baited and oviposition samplers. The habitats studied were a woodlot, an adjacent open field and the interface between them. The abundance of various mosquito species depended on habitat. In both years, *Culex pipiens* L., *Culex restuans* Theo., *Culiseta morsitans* Theo.,

Aedes vexans Meig., and the spring *Aedes* spp. complex were collected in the greatest magnitude in the woods. Females of *Anopheles walkeri* Theo. were most abundant in the field. Those of *Mansonia perturbans* Walker, were evenly distributed in all habitats. The New Jersey light and CDC traps were equally effective in the collection of *Culex pipiens*, *C. restuans* and *Culiseta morsitans*. The oviposition sampler was the most useful method for monitoring *Culex* spp. populations. The CDC light trap baited with dry-ice was the best over-all sampling device in this study. Animal-baited traps were least productive.

b) Westwood, A.R. and G.A. Surgeoner - *The use of plant phenology and an analysis of larval sampling techniques in a control strategy for spring Aedes mosquitoes.*

Over three years, the development of spring *Aedes* larvae was monitored in three habitats; a woodland pool, open field pool and cedar bog. Phenological stages of 29 plants, shrubs and trees corresponded to egg hatch, presence of first-instar larvae and the time for larval treatment. The combined results from all habitats indicated that first leaf and bloom of Crocus and Daffodil were the most reliable indicators of egg hatch. First-leaf stages of Honeysuckle, Poplar, Tamarack and Currant were the most accurate indicators for timing of larval control. A simple methodology was devised to indicate to abatement personnel when to initiate larval surveys and control procedures. Laboratory studies with four spring *Aedes* spp. indicated a developmental threshold which ranged from 3.66 to 4.31°C and thermal constants ranging from 247.6 to 273.6 degree days.

24. Sutton, J.C. and Gillespie, T.J. - *Computerized models for timing fungicides in onions.*

Our objectives are to develop fundamental models of the two principal diseases affecting onion leaves in Ontario. The diseases are botrytis leaf blight and downy mildew, and the models for the respective diseases are referred to as BOTCAST and DOWNCAST. The purpose of the models is to predict when the first fungicide spray is needed for disease control, and to identify periods when subsequent sprays may be withheld. Application of the models is intended to improve efficiency of fungicide utilization and to use fungicides only when they are needed.

In 1982 our focus was mainly on BOTCAST. We monitored botrytis leaf blight in a field plot at the Arkell Research Station. The following variables were monitored in the period from crop emergence to the time of complete crop destruction by the disease: 1. *Host variables:* plant height, number of leaves, leaf area; 2. *Pathogen variables:* (recorded daily) incidence of sporulation, numbers of airborne spores; 3. *Disease:* (recorded on 500 plants in 50 quadrats at 3-4 day intervals) number of lesions on each leaf of each plant, leaf dieback, number of dead leaves; 4. *Weather variables:* (monitored at 15 minute intervals using a micrologger) air temperature, air humidity (water potential), leaf surface wetness, irradiance, wind speed, rainfall. Analyses of these data are about half completed and are revealing principal factors affecting epidemic progress. Some of these findings confirm earlier observations, but new findings include numbers (or amounts) of infected dead leaves as an epidemic rate-limiting factor (related to the fact that spores are produced only on necrotic leaves).

Leaf blight distribution patterns in plots at Arkell and at the Muck Research Station, and in four growers' fields also were examined as a basis for developing a statistically sound sampling procedure for disease estimations. Such procedures are intended for use by scouts in IPM programs (we "lost" 3 growers' fields to hail and pesticide injury).

Microprocessor-based, battery powered weather-logging (temperature and humidity or leaf wetness) devices were acquired ("Datapods", Omnidata, Utah) and field tested. These are to be programmed to log temperature and humidity data at any desired interval (we used 0.5 h) and store these data for later readout. Infection severity values may be calculated from these weather factors. The number of severity units which may be accumulated to time the first spray in the BOTCAST model will be determined from data for epidemics monitored in 1982 and in earlier years.

At this point in time BOTCAST operates as follows. A datapod unit with temperature and wetness sensors is set up in the onion field when the onions emerge. Infection severity units are accumulated to give "cumulative infection severity values" (or CISV). These values are multiplied by sporulation potential values (SPV) of 1, 10, or 100, depending on whether 1, 2 to 3, 3 or 4 or more diseased leaves per plant are ⩾25% dead. CISV x SPV = Disease risk value (DRV). Two thresholds for disease risk values will be established. Threshold 1 is a warning that there is a risk of moderate disease severity (5-20 lesions/plant) after the next rain or after wet periods exceed "x" hours. The second threshold is of a risk of severe disease (20-200 lesions/plant) after the next rain or favorable wet period. Risk thresholds will be substantiated by field observations of numbers of lesions as well as dead leaves (using the sampling procedure under development). Subsequent sprays will be applied regularly OR spray intervals may be extended during dry periods (to be defined).

The DOWNCAST model is nearly complete, and arrangements have been made to field-test the model remote from commercial onion fields (farm near Ariss, Ontario) in 1983.

Also in 1982, fungicide-timing schemes for leaf blight management were tested in field plots at the Holland Marsh and at Arkell. Sprays (Bravo 500 at 5 ℓ/ha) were initiated when there were 1 or 3 lesions per leaf (or June 9 and 30, respectively). The respective programs required 7 and 5 sprays but controlled blight with similar efficiency. In a second series of plots at the Holland Marsh, sprays (Bravo 500 at 5 ℓ/ha; Maneb 80W at 2.25 kg/ha) were initiated when disease intensities reached 1 or 10 lesions/leaf. The Bravo program controlled blight when initiated at 1 lesion/leaf (9 sprays), but not at 10 lesions/leaf (3 sprays). However in both Maneb treatments, disease progressed as rapidly as in the unsprayed checks.

25. Tolman, J.H. and Tomlin, A.D.- *Feasibility of protecting radish, rutabaga and onion from root maggot damage by insecticide seed treatment.*

This project was funded in the latter part of 1982. A progress report is expected in 1984.

26. Tomlin, A.D. and Tolman, J.H. - *Feasibility of using parasites and/or predators in a program of integrated control of the onion maggot.*

Continued laboratory research has identified the conditions required for induction of diapause in the braconid wasp, *Aphaereta pallipes*. Emergence of vigorous adults following long term storage of infested host pupae should now be possible. Other experiments showed the importance of soil type and compaction on escape of *A. pallipes* adults from buried host pupae. Ten cm of loose muck proved no barrier to emerging *A. pallipes*; more than one cm of brick sand effectively blocked adult emergence. The effect of temperature on preoviposition and adult survival was also investigated. *A. pallipes* did not parasitize 100% of available host larvae, even after 72 hrs. Finally, as the number of ♀ *A. pallipes* increased, the number of hosts parasitized per ♀ declined.

Laboratory studies on the toxicity to *A. pallipes* and the staphylinid beetle, *Aleochara bilineata* of pesticides which are, or may be, used in onion pest management programs were completed. None of the fungicides tested (anilazine, chlorothalonil, metalaxyl, captafol) was toxic to either parasite spp. Of 5 herbicides tested (ioxynil, allidochlor, chlorpropham, cyanazine, niclofen) only ioxynil was toxic to *A. pallipes*; none was toxic to *A. bilineata*. Parathion was the most toxic of 22 direct contact insecticides to both parasite spp.; chlorfenvinphos was least toxic. Soil insecticide toxicity to the 2 spp. varied tremendously, with some soil insecticides being very toxic in both mineral and organic soil; chlorfenvinphos was the least toxic of the soil insecticides tested. An insecticide susceptible strain of *A. bilineata* was established and subsequent comparative tests indicated that the Thedford strain is highly resistant to cyclodiene insecticides.

Analysis of the arthropod predator complex associated with the onion maggot has expanded the list to 82 species, the bulk of which are comprised of 46 staphylinids, 21 carabids and 8 acarines. Many of these species have been observed feeding on various onion maggot stadia. The remainder have had their predatory status inferred from their habits in the onion field. Most species would be fairly general predators in any case.

Nine species of insect arthropods have been positively identified as protelean parasites of the onion maggot, but only 2, *A. pallipes* and *A. bilineata*, which also have alternative hosts, are of any important consequence in controlling onion maggot numbers.

Flight interception traps impregnated with rapid "knock-down" pyrethroid insecticides were used to monitor flying insect activity at Thedford. Particularly good records of Hymenoptera (excluding ants, bees and sawflies) flight activity over 18 weeks from June 18 to October 15, 1982 from a trap adjacent to the IPM block (no adulticide sprays) and a trap adjacent to the block under commercial treatment regimen (fonofos seed furrow treatment plus adulticide sprays) were kept. Hymenoptera catches were proportional to temperature, most Hymenoptera activity occurs from mid-August to early October and adulticide spraying may have been responsible for significantly lower Hymenoptera flight activity in the fonofos block. Hemiedaphic Collembola activity was enormously reduced in this block.

A comparable experiment run on rutabagas using similar traps but of different heights and surface areas clearly revealed Hymenoptera activity to be confined to a narrow lamina stretching, in cross-section, from the soil surface to a height slightly above the crop. Hymenoptera flight activity above this height is evidently greatly reduced.

A marked capture-recapture experiment was carried out to estimate natural population numbers of *A. bilineata* in a Thedford onion field. Laboratory experiments simulating field conditions revealed 53% of marked beetles retained their mark for 14 or more days with an uncorrected mortality rate of 10% after 14 days.

On three separate occasions during 1982 (14 June, 12 July, 30 August), 996 marked beetles were released from 6 release stations into the 15 x 45 m "release" block. Fifteen pitfall traps in each of the release block, an adjacent control block, and a nearby fonofos treated block, were used to monitor *A. bilineata* populations, and for comparison purposes. Marked recapture rates were 1.5, 1.1 and 1.3% respectively in the release block for each of the 3 release dates. Recapture rates of 0.1, 0.2 and 0.0% were made in the adjacent block but no recaptures were made in the fonofos block (also subjected to adulticide sprays), 94 m away. Mean combined catches per block of marked, unmarked and wild *A. bilineata* adults over 28 collection dates were 12.4, 5.9 and 0.4 respectively for the same blocks.

Adjacent 45 x 15 m blocks were established in one corner of a commercial onion field on the Thedford-Grand Bend Marsh. Chlorfenvinphos 5G was applied as a seed furrow treatment; no other insecticides were applied to either block at any time throughout the summer. Beginning June 2 and continuing for 15 weeks, 900-1000 *A. bilineata* were released weekly on one block. Three "micromountains" (0.25 m^2 beds of sliced onion seeded with onion maggot eggs) were established biweekly on each block. Four-five days after completion of onion maggot pupation "micromountains" were returned to the laboratory, pupae collected and examined for parasites. In the release block, mean parasitism by *A. bilineata* ranged from a low of 8.3% during the hottest part of the summer to a high of 33.3% for the first set of "micromountains"; mean parasitism was 21.3%. Release of *A. bilineata* increased parasitism over the control block on only two occasions. *A. pallipes* was present at low levels throughout the summer.

Onion damage counts taken throughout the summer both in the experimental blocks and the adjacent grower field yielded the following results:

Soil Insecticide	*Aleochara Bilineata*	Foliar Insecticide	% Onion Loss (Gen. I)	% Onion Damage (Gen. II)
-	-	-	46.6 ± 3.5 a	7.7 ± 2.1 c
+	-	-	15.6 ± 2.0 b	6.4 ± 1.1 cd
+	+	-	11.8 ± 2.3 b	3.2 ± 0.9 d
+	-	+	16.9 ± 2.4 b	3.0 ± 0.7 d

It is readily apparent that in 1982 first generation onion maggot damage was far more important. Application of a soil insecticide in the seed furrow is the most effective way to control this damage. Both release of *A. bilineata* and application of foliar insecticides significantly decreased second generation onion maggot damage.

Concerted laboratory efforts during the winter of 1981-82 were directed towards improving the method of field dispersal of host pupae parasitized by *A. pallipes*. A sealed "packet" of screening containing a mixture of muck and host pupae buried 5-6 cm beneath the surface effectively contained non-parasitized onion maggot adults while allowing ready escape of the parasite. In late August 0.2 ha release block were established in two fields of recently harvested pickling onions. Control sites were established at least 100 m from each block. Twenty release points were set up in each block. Parasitized pupae were distributed at a rate of one "packet"/release point on the Donald block and two "packets"/release point on the Carrothers block. Each "packet" contained 500 parasitized host pupae. Four releases were made from August 25 - September 24.

Rates of parasitism were established by: a) extracting onion maggot pupae from "micromountains"; and b) extracting pupae from 1.0 m rows of sprouted pickling onions infested with onion maggot eggs. Pupae collected using method b) are in storage and will be checked for parasitism in January. Examination of pupae collected using method a) showed parasitism by *A. pallipes* increased from an average of 4.0% at the control sites to an average of 13.9% in the release blocks. A very satisfactory parasitism rate of 40.9% was recorded in "micromountains" placed in the release blocks on September 20, emphasizing the potential importance of *A. pallipes* late in the season.

A. bilineata was also found parasitizing onion maggot pupae in the release blocks at rates as high as 55%. Total parasitism due to *A. bilineata* and *A. pallipes* ranged from 32.3% to 62.9%, averaging 48.9%.

27. Tu, C.M. and Miles, J.R.W. - *Influence of environmental factors on the rate of microbial degradation of pesticides in soil and water.*

The persistence of the organophosphorus insecticides, chlorfenvinphos and chlorpyrifos, was studied in sterile and natural mineral (sandy loam) and organic (muck) soils at three temperatures (3°, 15° and 28°C) and in a separate experiment, at 4 moisture levels. In sterile soils chlorfenvinphos was quite stable with >80% recovered at 24 wk (28°). Chlorpyrifos was less stable at 28°, with 68% remaining in muck, and 38% in sandy loam at 24 wk. It was more stable at 3° and 15° than at 28°. In natural (non-sterile) soils there were marked differences in persistence at the 3 temperatures. At 3°, 15° and 28° chlorfenvinphos had half-lives in muck of >24, 11 and 3.5 wk respectively, and in sandy loam 18, 4 and 3 wk respectively. At 3°, 15° and 28° chlorpyrifos in muck had half-lives of >24, 15 and 6.5 wk and in loam, 16, 6.5 and 2.5 wk respectively.

The study of the effect of moisture on the persistence of chlorfenvinphos and chlorpyrifos is being conducted on "air dried" soils and soils containing 20, 40 and 60% of moisture holding capacity (MHC). At 8 wks it is already evident that persistence in the air dry natural sandy loam is quite different from that in the moist samples but no real differences in persistence

exist between the 20, 40 and 60% MHC samples. In the natural muck however, the persistence of both insecticides in the 20, 40 and 60% MHC soils is inversely proportional to the moisture percentages.

Chlorpyrifos disappeared most rapidly from air-dry muck while chlorfenvinphos was more persistent in the air-dry than in the moist muck. This study will be continued for 24 wk.

28. Fisher, P. and Wheatstone, W.A. - *I.P.M. in Ontario.*

Since the beginning of the apple pest management program, there have been changes in pest complex, recommended and available control materials and growers' technology. Pest management specialists have had to deal with these changes.

Changes in pest complex have resulted from new spray programs and/or changed habits of the pest itself. Where European red mite was considered the primary mite pest, two-spotted spider mite is beginning to dominate. With the use of early season synthetic pyrethroids for tentiform leafminer, the traditional spring pests such as spring feeding caterpillars and tarnished plant bug are well controlled. However, "new" pests such as woolly apple aphid and oblique banded leafroller are potential threats. White apple leafhopper is also a relatively new problem. Scale populations which have fluctuated for the past 3 years appear to be increasing again.

New pest management techniques are needed to deal with scale insects. Work was done in 1981 and 1982 to test an effective method of monitoring adult male scale with pheromone traps. Supracide was tested in field trials as a possible control for overwintering scale adults.

Resistance of pests to chemical controls has led to changes in chemicals available. Testing apple scab for resistance to Benomyl® and Cyprex® was continued in 1982. A small survey of European red mite resistance to Plictran® was completed. A new resistance problem developed this spring when resistance of tentiform leafminer to synthetic pyrethroids was discovered in an isolated area.

Pest management specialists have dealt with changes in growers' technology by assessing new tools available. Projects this summer included testing the efficacy of the Kinkeldar electrostatic sprayer and following the performance of the Reuter Stokes Apple Scab Predictor.

RESEARCH PROPOSALS FUNDED IN 1981/82 AND COMPLETED IN 1982/83.

29. Birmingham, B.C., Thorndyke, M., and Colman, B. - *The dynamics and persistence of the herbicide Aqua-Kleen® (2,4-D) in small artificial ponds and its impact on non-target microflora.*

Outdoor artificial ponds planted with *Myriophyllum spicatum* were treated with Aqua-Kleen at 20 lb active ingredient/acre. The butoxyethanol ester of 2,4-D (BEE) did not persist in pond water (0.16 mg/ℓ one day after application) and decreased to less than 0.01 mg/ℓ within 15 days. Over the same period the 2,4-D acid (the main hydrolysis product of BEE) level in pond water rose to 3 mg/ℓ decreasing gradually to about 1 mg/ℓ after 85 days and 0.2 mg/ℓ after 178 days. Residues of the 2,4-D acid breakdown products 2,4-dichlorophenol or 2,4-dichloroanisole were not detectable (at the 0.01 mg/ℓ level) in treated pond water at any stage of this study.

The ester persisted much longer in the pond sediment (1.7 μg/g dry wt one week after treatment) decreasing to 0.1 μg/g dry wt after 7 weeks. Initial levels of 2,4-D acid in the sediment hydrosoil were high (6.7 μg/g dry wt one day after treatment). Thereafter, 2,4-D acid residues in the sediment decreased and were similar to pond water levels.

Dramatic increases in 2,4-D residues taken up by plant material were observed during the 2 weeks following treatment (mean maximum of 206 μg/g dry wt plant material nine days after treatment). 2,4-D residue levels dropped to 10-20 μg/g dry wt plant material after this period.

Mean water temperature of the ponds dropped from 25°C at treatment to freezing temperatures within two months and the ponds were frozen for the remainder of the study. The last sample (residue analysis) was obtained 178 days after treatment just after spring thaw.

M. spicatum had completely collapsed 5 days after application and filamentous green algae had invaded the ponds by 21 days. Significant decreases in dissolved O_2 level and pH, and increases in dissolved inorganic carbon occurred 7 days after treatment. No dissolved nutrient increase was detected on decay of the weeds and unicellular algae did not bloom.

Zooplankton numbers in treated ponds declined in the 14 days following application due to an absence of rotifers and ostracods and reduced populations of copepods and cladocerans.

This study indicates that 2,4-D breaks down slowly in small enclosed bodies of water under Canadian climatic conditions. Its impact is due to the removal of the weed-bed ecosystem.

30. George, J.A. - *Evaluation of the flatworm, Dugesia tigrina for Culex abatement.*

Laboratory studies. Adult emergence per 100 *Culex* sp. larvae was reduced by crowding when larval density exceeded 100 per litre and planarians had limited effects on the total numbers of adults emerging from a litre of water at these high densities. Even though predation rates were high, at high larval densities,

the survival rates of the remaining larvae were increased with reduced competition. At lower densities, such as 50 first instar larvae per litre, adult emergence was reduced by over 90% by two or more planarians but destruction of all larvae was not achieved even at 8 planarians per litre. Hence the emergence of mosquito adults from a given volume of water seems to be buffered in such a manner that the effects of planarian predators are minimized at high larvae densities. At larval densities below 100 per litre, adult reduction can be substantial even though complete removal is unlikely.

Survival in catch basins. Tests have been underway since 1980 to determine if *D. tigrina* would survive in catch basins. A total of 80 planarians was introduced into each of 27 catch basins in Komoka village on July 15, 1980 and monitored twice a month by counting the planarians on the undersides of Styrofoam® floats. In July, 1982, planarians were still present in 11 of the original 27 catch basins innoculated. Five of the 11 had an average of over 16 planarians per float per inspection. In catch basin numbered 27, planarians survived in large numbers. The average in this basin was 60 in 1980, 38 in 1981 and 63 in 1982. In August 1982, planarians were transferred on floats from basin no. 27 to three other basins from which they had disappeared. In this manner it will be determined if the strain of planarians in no. 27 has adapted to other catch basins as well as to the conditions in no. 27.

31. Thompson, D.G., Stephenson, G.R., Solomon, K.R., and Bowley, C.S. - *Persistence of 2,4-D and dichlorprop in various soils in Ontario.*

The phenoxy herbicides 2,4-dichlorophenoxy acetic acid (2,4-D) and 2-(2,4-dichlorophenoxy) propanoic acid (2,4-DP) are considered to be non-persistent in soils. However, very little information is available regarding the persistence of these chemicals in soils under typical field conditions found in Ontario. There have been suggestions that extreme conditions of low pH and low temperatures might increase the longevity of these herbicides in soil.

A number of experiments were initiated to study the soil persistence of 2,4-D and 2,4-DP following application at typical rates for agriculture (560 g AI/ha) and for forestry (2.24 kg AI/ha). The objectives of these experiments were:

a) to compare the persistence of 2,4-D and 2,4-DP in both northern and southern agricultural soils.

b) to study the longevity of 2,4-D in a sandy soil and a clay soil typical of forestry situations in northern Ontario.

Soils selected for study included a Guelph loam and a New Liskeard clay representing agricultural soils from southern and northern Ontario, both with pH = 7.2. Forestry soils selected were on Englehart fine sand (pH = 5.2) and an Englehart clay (pH = 6.4). Soil samples were taken from initiation to soil freeze up. Extracts were analyzed by gas-liquid chromatography using electron capture detection of the methyl ester

derivative of the herbicide under investigation. Results indicated that the half-life of 2,4-D and 2,4-DP in both northern and southern trial sites regardless of application rate or soil type were less than one month (Figs. 7, 8 & 9).

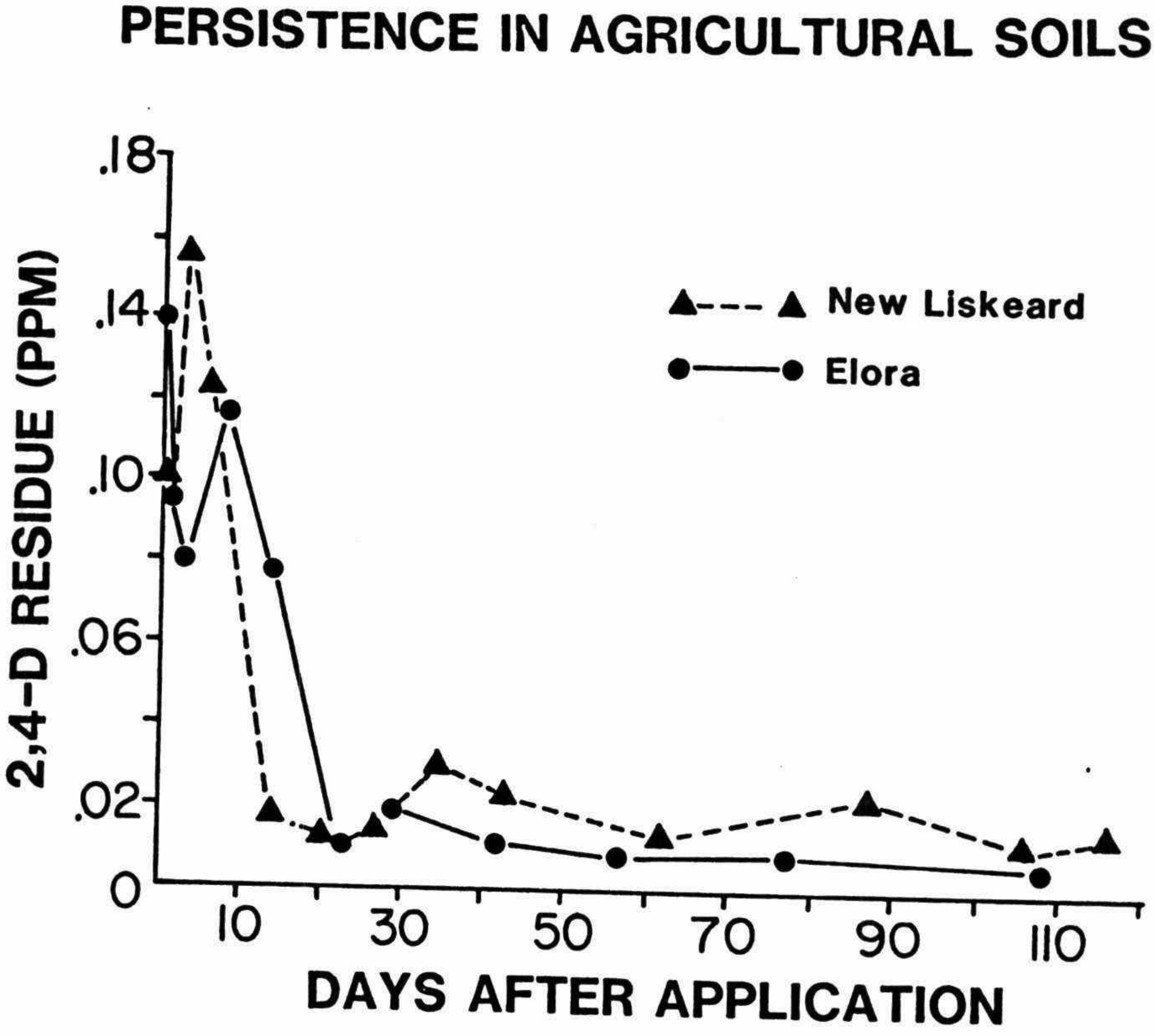

Fig. 7. Residues of 2,4-D in agricultural soils in northern (New Liskeard) and southern (Elora) Ontario.

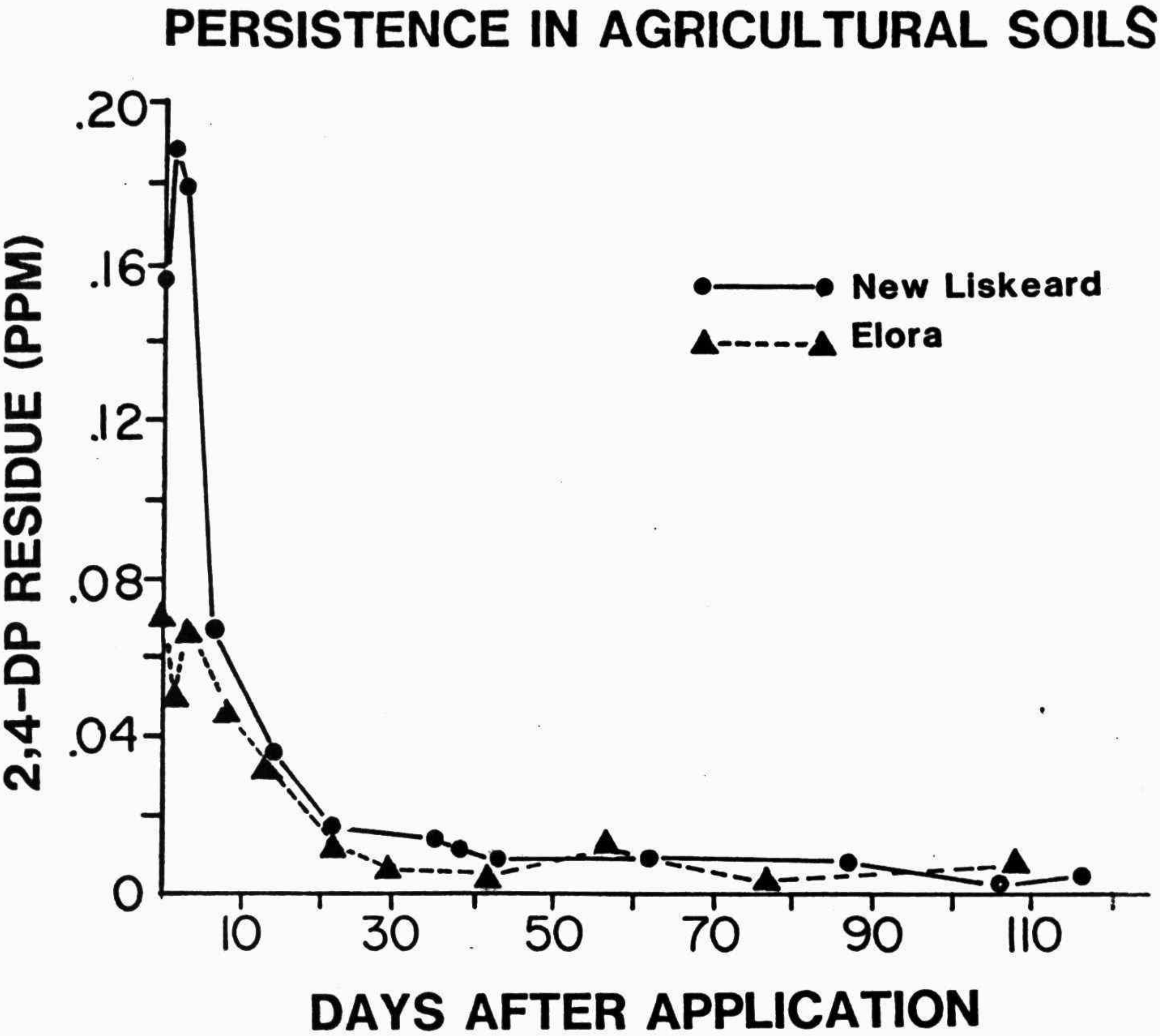

Fig. 8. Residues of 2,4-DP in agricultural soils in northern (New Liskeard) and southern (Elora) Ontario.

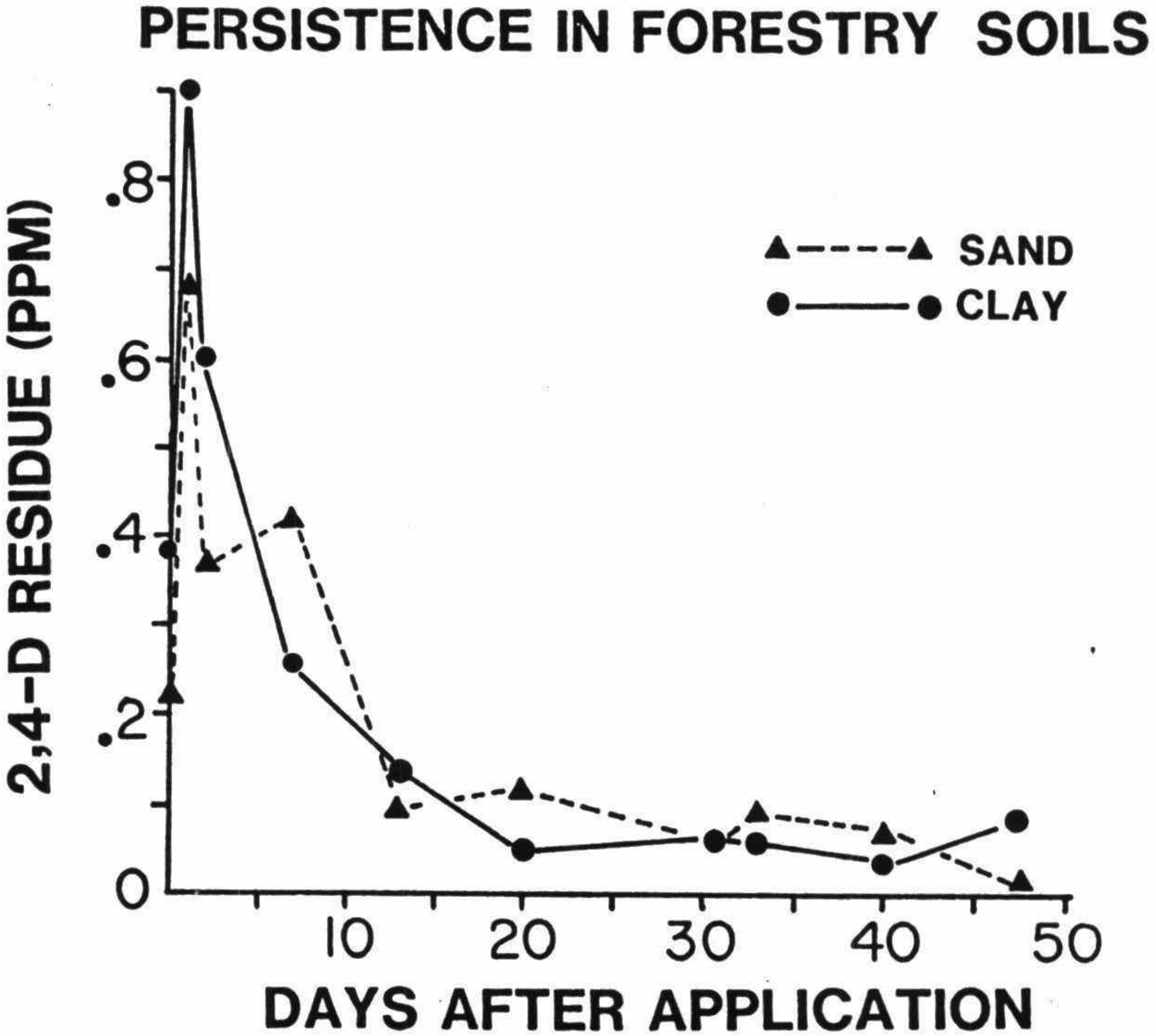

Fig. 9. Residues of 2,4-D in sand and clay soils of Ontario.

APPENDIX IV. Publications and theses relating to Ontario Pesticides Advisory Committee Research Programs, April 1, 1982 - March 31, 1983

Chapman, R.A., and C.R. Harris. 1981. Persistence of four pyrethroid insecticides in a mineral and an organic soil. J. Environ. Sci. Health, B16: 605-615.

Chapman, R.A., C.M. Tu, C.R. Harris, and Carol R. Harris. 1982. Biochemical and chemical transformations of phorate, phorate sulfoxide and phorate sulfone in natural and sterile, mineral and organic soil. J. Econ. Entomol. 75: 112-117.

Chapman, R.A., C.M. Tu, C.R. Harris and D. Dubois. 1982. Biochemical and chemical transformations of terbufos, terbufos sulfoxide and terbufos sulfone in natural and sterile, mineral and organic soils. J. Econ. Entomol. 75: 955-960.

Ellis, C.R., 1983. A survey of granular application equipment and insecticide rates used for control of corn rootworms (Coleoptera: Chrysonelidae) in southern Ontario. Proceedings of Entomological Society of Ontario. Vol. 113: 29-34.

Harris, C.R., H.J. Svec, J.H. Tolman, A.D. Tomlin, and F.L. McEwen. 1981. A rational integration of methods to control onion maggot in southwestern Ontario. Proc. 1981 British Crop Prot. Conf. - Pests and Diseases 3: 789-799.

Helson, B.V., and G.A. Surgeoner. 1983. Effect of temperature and stage of development on susceptibility of Aedes Euedes and Aedes Stimulans (Diptera: Culicidae) larvae to temephos. Can. Ent. 115: 623-628.

Miles, J.R.W., C.R. Harris, and D.C. Morrow. 1983. Assessment of hazards associated with pesticide container disposal and of rinsing procedures as a means of enabling disposal of pesticide containers in sanitary landfills. J. Environ. Sci. Health, B18(3), 305-315.

Rodrigues, C.S. 1982. Effects of insecticides including insect growth regulators on black fly (Diptera: Simulidae) larvae and associated nontarget stream invertebrates. Ph.D. thesis presented to the Faculty of Graduate Studies, University of Guelph.

Sharom, M.S., and J.R.W. Miles. 1981. The degradation of parathion and DDT in aqueous systems containing organic additives. J. Environ. Sci. Health. B16(6): 703-711.

Sharom, M.S., J.R.W. Miles, C.R. Harris, and F.L. McEwen. 1981. Organochlorine and organophosphorus insecticide residues in the organic soil and drainage system of an agricultural watershed planted with vegetables. MARDI Res. Bull. 8: 61-73.

Smith, M.V. 1983. Northern (Diabrotica longicornis) and Western (Diabrotica vergifera) corn rootworm beetles as competitors of foraging honey bees, Apis mellifera. Canadian Beekeeping. Vol. 10: 173-174.

Van Amelsvoort, G., and J.A. George. 1982. Lubricants reduce fission of the planarian flatworm (Dugesia tigrina) (Girard) Can. Journal of Zoology, Vol. 60: No. 5: 974-975.

Westwood, A.R., G.A. Surgeoner, and B.V. Helson. 1983. Survival of spring Aedes spp. mosquito (Diptera: Culicidae) larvae in ice-covered pools. The Canadian Entomologist. 115: 195-197.

APPENDIX V

STATISTICAL REVIEW, 1973-74 to 1982-83
Proposals Received (R) Versus Funded (F)

TABLE I

Research Centre	73-74		74-75		75-76		76-77		77-78		78-79		79-80		80-81		81-82		82-83		Total	
	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F	R	F
Brock	–	–	–	–	2	1	1	1	1	1	1	–	2	0	–	–	–	–	1	–	8	3
Carleton	2	–	1	–	–	–	–	–	–	–	1	1	1	1	1	–	1	–	1	–	8	2
Guelph	8	5	13	7	12	8	11	9	16	8	18	11	29	16	25	11	14	13	20	15	166	103
Lakehead	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	3	0
Laurentian	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	2	0
McMaster	1	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	3	0
ORF	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0
Ottawa	1	–	1	–	–	–	–	–	–	–	1	1	1	1	3	–	–	–	–	–	7	2
Queens	3	–	2	–	2	–	1	–	1	–	–	–	–	–	1	–	–	–	1	–	11	0
Ridgetown	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1	0
Sault	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	1	2	1	1	1	7	3
Toronto	12	3	6	1	1	1	3	1	3	1	–	–	3	0	1	–	–	–	4	1	33	8
Waterloo	4	2	3	3	7	3	2	1	6	2	4	2	3	2	3	2	3	1	2	–	37	18
Western	4	1	3	1	3	3	4	3	5	5	6	4	4	4	6	4	7	6	7	7	49	38
York	3	2	3	2	5	3	4	4	3	2	4	1	–	–	1	1	1	1	–	–	24	16
Others	3	1	10	4	5	3	1	–	1	1	4	–	6	2	7	2	4	3	8	4	49	20
	44	14	43	18	37	22	27	19	37	20	39	20	49	26	54	21	33	25	46	28	409	213

APPENDIX V

STATISTICAL REVIEW 1973-74 to 1982-83

Disbursement of Funds in Dollars

TABLE 2

Research Centre	73-74	74-75	75-76	76-77	77-78	78-79	79-80	80-81	81-82	82-83	Total
Brock	-	-	4,200	4,200	3,500	-	-	-	-	-	11,900
Carleton	-	-	-	-	-	9,500	1,875	-	-	-	11,375
Guelph	45,675	53,212	52,627	72,784	106,940	362,400 (1)	226,800	120,270	173,640	156,515	1,370,863
Lakehead	-	-	-	-	-	-	-	-	-	-	-
Laurentian	-	-	-	-	-	-	-	-	-	-	-
McMaster	-	-	-	-	-	-	-	-	-	-	-
ORF	-	-	-	-	-	-	-	-	-	-	-
Ottawa	-	-	-	-	-	12,000	14,000	-	-	-	26,000
Queens	-	-	-	-	-	-	-	-	-	-	-
Sault	-	-	-	-	-	-	-	13,000	11,200	11,550	35,750
Toronto	15,420	4,373	13,200	11,300	18,000	-	-	-	-	15,010	77,303
Waterloo	20,605	17,175	10,050	3,000	10,700	16,100	18,800	11,500	10.900	-	118,830
Western	5,000	4,000	18,170	28,860	37,500	38,700	26,800	39,000	62,940	77,050	338,020
York	10,800	11,600	27,020	28,028	11,300	7,600	-	3,000	7,000	-	106,348
Others	2,500	8,000	10,750	-	8,000	-	8,500	12,500	26,000	36,500	112,750
	100,000	98,360	136,017	148,172	195,940	446,300	296,775	199,270	291,680	296,625	2,209,139

(1) Included $60,000 to Arboretum at Guelph

APPENDIX V STATISTICAL REVIEW 1973-74 to 1982-83

Disbursement of Funds by Objective

TABLE 3

YEAR	OBJECTIVE 1 $	OBJECTIVE 2 $	OBJECTIVE 3 $	TOTALS $
1973-74	18,105	37,720	44,175	100,000
1974-75	17,475	41,673	39,212	98,360
1975-76	4,800	78,884	52,333	136,017
1976-77	9,000	64,248	74,924	148,172
1977-78	60,840	77,900	57,200	195,940
1978-79	83,200	71,500	291,600	446,300
1979-80	111,875	58,600	126,300	296,775
1980-81	72,500	45,500	81,270	199,270
1981-82	78,500	127,780	85,400	291,680
1982-83	46,500	77,400	172,725	296,625
Total:	502,795	681,205	1,025,139	2,209,139

Objective 1 - To find alternative pesticides for those deemed environmentally hazardous and thus restricted in use.

Objective 2 - To determine potential environmental hazards with pesticides currently in use.

Objective 3 - To reduce pesticide input into the environment.